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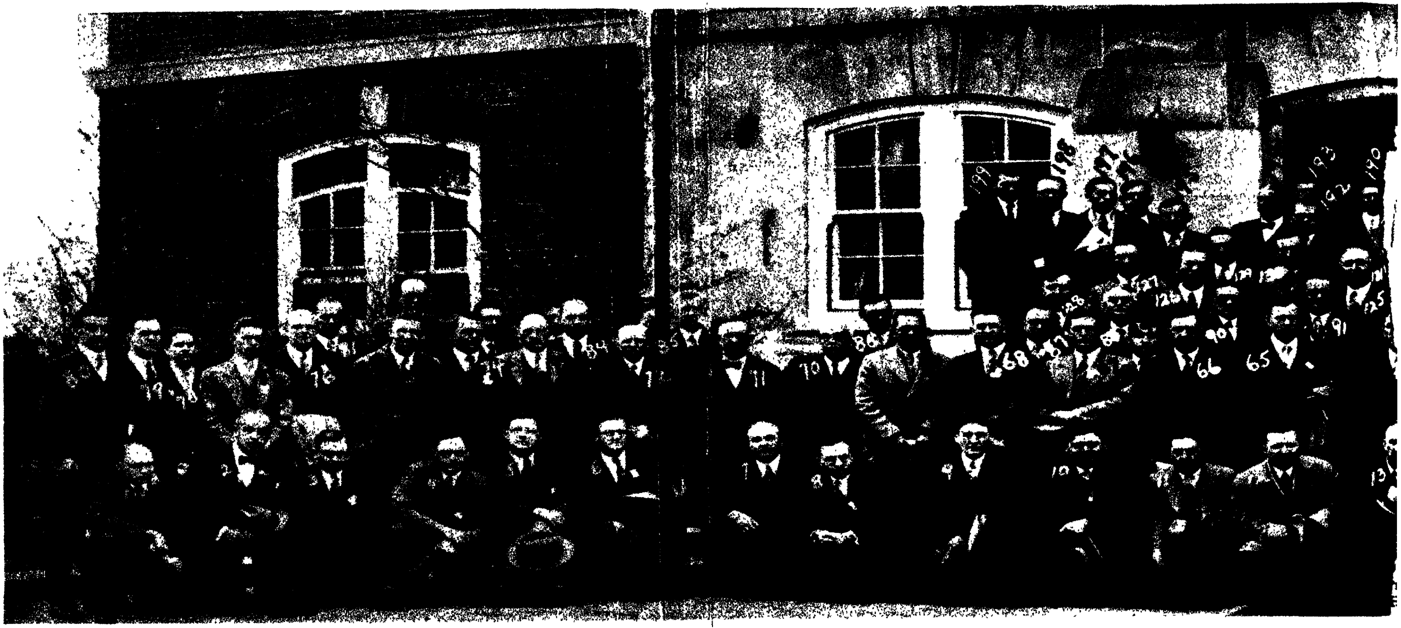

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Second Annual Meeting Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting.)

Third Annual Meeting, Washington, D. C., Aug. 15–18, 1891. President, James Fletcher; First Vice-President, F. H. Snow; Second Vice-President, Herbert Osborn; Secretary, L. O. Howard.

Fourth Annual Meeting, Rochester, N. Y., Aug. 15–16, 1892. President, J. A. Lintner; First Vice-President, S. A. Forbes; Second Vice-President, J. H. Comstock; Secretary, F. M. Webster.

Fifth Annual Meeting, Madison, Wisc., Aug. 14-16, 1893. President, S. A. Forbes; First Vice-President, C. J. S. Bethune; Second Vice-President, John B. Smith; Secretary, H. Garman.

Sixth Annual Meeting, Brooklyn, N. Y., Aug. 14–15, 1894. President, L. O. Howard; First Vice-President, John B. Smith; Second Vice-President, F. L. Harvey; Secretary, C. P. Gillette.

Seventh Annual Meeting, Springfield, Mass., Aug. 27–28, 1895. President, John B. Smith; First Vice-President, C. H. Fernald; Secretary, C. L. Marlatt.

Eighth Annual Meeting, Buffalo, N. Y., Aug. 21–22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

Ninth Annual Meeting, Detroit, Mich., Aug. 12–13, 1897. President, F. M. Webster; First Vice-President, Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

Tenth Annual Meeting, Boston, Mass., Aug. 19–20, 1898. President, Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, C. L. Marlatt.

Eleventh Annual Meeting, Columbus, Ohio, Aug. 18–19, 1899. President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, A. H. Kirkland.

Twelfth Annual Meeting, New York, N. Y., June 22–23, 1900. President, Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

Thirteenth Annual Meeting, Denver, Colo., Aug. 23–24, 1901. President, C. P. Gillette; First Vice-President, A. D. Hopkins, Second Vice-President, E. P. Felt; Secretary, A. L. Quaintance.

Fourteenth Annual Meeting, Pittsburgh, Pa., June 27–28, 1902. President, A. D. Hopkins; FirstVice-President, E. P. Felt; Second Vice-President, T. D. A. Cockerell; Secretary, A. L. Quaintance.

Fifteenth Annual Meeting, Washington, D. C., Dec. 26–27. 1902. President, E. P. Felt; First Vice-President, W. H. Ashmead; Second Vice-President, Lawrence Bruner; Secretary, A. L. Quaintance.

Sixteenth Annual Meeting, St. Louis, Mo., Dec. 29–31, 1903. President, M. V. Slingerland; First Vice-President, C. M. Weed; Second Vice-President, Henry Skinner; Secretary, A. F. Burgess.

Seventeenth Annual Meeting, Philadelphia, Pa., Dec. 29-30, 1904. President, A. L. Quaintance; First Vice-President, A. F. Burgess; Second Vice-President, Mary E. Murtfeldt; Secretary, H. E. Summers

Eighteenth Annual Meeting, New Orleans, La., Jan. 1–4, 1906. President, H. Garman; First Vice-President, E. D. Sanderson; Second Vice-President, F. L. Washburn; Secretary, H. E. Summers.

Nineteenth Annual Meeting, New York, N. Y., Dec. 28-29, 1906. President, A. H. Kirkland; First Vice-President, W. E. Britton; Second Vice-President, H. A. Morgan; Secretary, A. F. Burgess.

Twentieth Annual Meeting, Chicago, Ill., Dec. 27–28, 1907. President, H. A. Morgan; First Vice-President, H. E. Summers; Second Vice-President, W. D. Hunter; Secretary, A. F. Burgess.

Twenty-first Annual Meeting, Baltimore, Md., Dec. 28–29, 1908. President, S. A. Forbes; First Vice-President, W. E. Britton; Second Vice-President, E. D. Ball; Secretary, A. F. Burgess.

Twenty-second Annual Meeting, Boston, Mass., Dec. 28–29, 1909. President, W. E. Britton; First Vice-President, E. D. Ball; Second Vice-President, H. E. Summers; Secretary, A. F. Burgess.

Twenty-third Annual Meeting, Minneapolis, Minn., Dec. 28–29, 1910. President, E. D. Sanderson; First Vice-President, H. T. Fernald; Second Vice-President, P. J. Parrott; Secretary, A. F. Burgess.

Twenty-fourth Annual Meeting, Washington, D. C., Dec. 27–29, 1911. President, F. L. Washburn; First Vice-President, E. D. Ball; Second Vice-President, R. H. Pettit; Secretary, A. F. Burgess.

Twenty-fifth Annual Meeting, Cleveland, Ohio, Jan. 1–3, 1913. President, W. D.

Hunter; First Vice-President, T. J. Headlee; Second Vice-President, R. A. Cooley; Secretary, A. F. Burgess.

Twenty-sixth Annual Meeting, Atlanta, Ga., Dec. 31, 1913–Jan. 2, 1914. President, P. J. Parrott; First Vice-President, E. L. Worsham; Second Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Twenty-seventh Annual Meeting, Philadelphia, Pa., Dec. 28–31, 1914. President, H. T. Fernald; First Vice-President, Glenn W. Herrick; Second Vice-President, W. E. Britton; Third Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Special Meeting, Berkeley, Cal., Aug. 9–10, 1915. (Officers same as for Twenty-eighth Annual Meeting.)

Twenty-eighth Annual Meeting, Columbus, Ohio, Dec. 27–30, 1915. President, Glenn W. Herrick; First Vice-President, R. A. Cooley; Second Vice-President, W. E. Rumsey; Third Vice-President, E. F. Phillips; Secretary, A. F. Burgess.

Twenty-ninth Annual Meeting, New York, N. Y., Dec. 28–30, 1916. President, C. Gordon Hewitt; First Vice-President, G. A. Dean; Second Vice-President, E. D. Ball; Third Vice-President, W. J. Schoene; Fourth Vice-President, T. J. Headlee; Secretary, A. F. Burgess.

Thirtieth Annual Meeting, Pittsburgh, Pa., Dec. 31, 1917–Jan. 2, 1918. President, R. A. Cooley; First Vice-President, W. E. Hinds; Second Vice-President, A. W. Morrill; Third Vice-President, G. M. Bentley; Fourth Vice-President, B. N. Gates; Secretary, A. F. Burgess.

Thirty-first Annual Meeting, Baltimore, Md., Dec. 26–27, 1918. President, E. D. Ball; First Vice-President, W. C. O'Kane; Second Vice-President, G. P. Weldon; Third Vice-President, E. C. Cotton; Fourth Vice-President, Franklin Sherman, Jr.; Secretary, A. F. Burgess.

Thirty-second Annual Meeting, St. Louis, Mo., Dec. 31, 1919–Jan. 2, 1920. Presisent, W. C. O'Kane; First Vice-President, A. G. Ruggles; Second Vice-President, H. J. Quayle; Third Vice-President, E. C. Cotton; Fourth Vice-President, W. E. Britton; Secretary, A. F. Burgess.

Thirty-third Annual Meeting, Chicago, Ill., Dec. 29–31, 1920. President Wilmon Newell; First Vice-President, H. A. Gossard; Second Vice-President, E. M. Ehrhorn; Third Vice-President, J. G. Sanders; Fourth Vice-President, F. B. Paddock, Secretary, A. F. Burgess.

Thirty-fourth Annual Meeting, Toronto, Canada, Dec, 29–31, 1921. President, George A. Dean; First Vice-President, Arthur Gibson; Second Vice-President, E. O. Essig; Third Vice-President, A. G. Ruggles; Fourth Vice-President, H. F. Wilson; Secretary, A. F. Burgess.

Thirty-fifth Annual Meeting, Boston, Mass., Dec. 28–30, 1922. President, J. G. Sanders; First Vice-President, J. M. Swaine; Second Vice-President, A. L. Lovett; Third Vice-President, R. W. Harned; Fourth Vice-President, M. C. Tanquary; Secretary, A. F. Burgess.

Thirty-sixth Annual Meeting, Cincinnati, Ohio, Dec. 29, 1923–Jan. 2, 1924. President, A. G. Ruggles; First Vice-President, H. A. Gossard; Second Vice-President, H. J. Quayle; Third Vice-President, P. A. Glenn; Fourth Vice-President, S. B. Fracker; Secretary, A. F. Burgess.

Thirty-seventh Annual Meeting, Washington, D. C., Dec. 31, 1924–Jan. 3, 1925. President, A. F. Burgess; First Vice-President, M. C. Tanquary; Second Vice-President, H. S. Smith; Third Vice-President, E. R. Sasscer; Fourth Vice-President, R. W. Harned; Secretary, C. W. Collins.

Thirty-eighth Annual Meeting, Kansas City, Mo., Dec. 29, 1925–Jan. 1, 1926. President, H. A. Gossard (died in office December 18, 1925); First Vice-President R. N. Chapman (assumed duties of President for remainder of term); Second Vice-President, Leroy Childs; Third Vice-President, C. H. Hadley; Fourth Vice-President, R. L. Webster; Secretary, C. W. Collins.

Thirty-ninth Annual Meeting, Philadelphia, Pa., Dec. 28, 1926–Jan. 1, 1927. President, Arthur Gibson; First Vice-President, C. J. Drake; Second Vice-President, W. B. Herms; Third Vice-President, L. A. Strong; Fourth Vice-President, J. I. Hambleton; Fifth Vice-President, W. E. Hinds; Secretary, C. W. Collins.

Fortieth Annual Meeting, Nashville, Tenn., Dec. 27–31, 1927. President, R. W. Harned; First Vice-President, W. P. Flint; Second Vice-President, R. W. Doane; Third Vice-President, Franklin Sherman; Fourth Vice-President, J. H. Montgomery; Fifth Vice-President, F. E. Millen; Secretary, C. W. Collins.

LIST OF MEMBERS

ACTIVE MEMBERS

Abbott, W. S., U. S. Bureau of Entomology, Vienna, Va.
Ackerman, A. J., U. S. Bureau of Entomology, Washington, D. C.
Ainslie, C. N., 2000 So. St. Aubin St., Sioux City, Iowa.
Ainslie, George G., R. R. 9, Knoxville, Tenn.
Alden, C. H., State Bd. Ent., Cornelia, Ga.
Aldrich, J. M., U. S. National Museum, Washington, D. C.
Alexander, C. P., M. A. C., Amherst, Mass.
Allen, H. W., Box H., Moorestown, N. J.
Allen, R. H., Department of Agriculture, State House, Boston, Mass.
Arnold, George F., A. and M. College, Miss.
Atwood, George G., Depart. Farms and Markets, Albany, N. Y.

Babcock, K. W., 10 Court St., Arlington, Mass.
Babcock, O. G., Box 407, Sonora, Texas.
Back, E. A., U. S. Bureau of Entomology, Washington, D. C.
Baerg, W. J., Fayetteville, Ark.
Bailey, H. L., Bradford, Vt.
Baker, A. C., U. S. Bureau of Entomology, Washington, D. C.
Baker, A. W., Ontario Agricultural College, Guelph, Canada.
Balduf, W. V., 400 Nat. Hist. Bldg., Urbana, Ill.
Ball, E. D., Ent. Laboratory, Sanford, Fla.
Banks, C. S., Bureau of Science, Manila, P. I., Box 2314.
Barber, E. R., Canal and Baronne Sts., New Orleans, La.
Barber, G. W., 10 Court St., Arlington, Mass.
Barber, H. S., U. S. Bureau of Entomology, Washington, D. C.
Barber, T. C., Box 639, Brownsville, Texas.
Barnes, D. F., Bur. of Ent., Melrose Highlands, Mass.
Bartlett, Oscar C., Box 1857, Phoenix, Ariz.
Basinger, A. J., Citrus Exp. Station, Riverside, Calif.
Batchelder, C. H., 170 Beech Ave., Melrose, Mass.
Becker, G. G., 701 Polk Ave., Houston, Texas.
Beckwith, C. S., Cranberry Exp. Sta., Pemberton, N. J.

Bedford, Theo., Welcome Tropical Research Laboratory, Khartum, Sudan.
Bentley, G. M., University of Tennessee, Knoxville, Tenn.
Berger, E. W., University of Florida, Box 656, Gainesville, Fla.
Bethune, C. J. S., Guelph, Ontario, Canada.
Beyer, A. H., Auburndale, Fla.
Bigger, J. H., 1114 So. Main St., Jacksonville, Ill.
Bilsing, S. W., College Station, Texas.
Bishopp, F. C., U. S. Bureau of Entomology, Box 208, Dallas, Texas.
Blackman, M. W., N. Y. State College of Forestry, Syracuse, N. Y.
Bourne, A. I., Agricultural Experiment Station, Amherst, Mass.
Boyden, B. L., Box 1691, Tampa, Fla.
Brannon, C. H., College Station, Raleigh, N. C.
Brannon, L. W., Woodland P. O., Birmingham, Ala.
Brimley, C. S., Department of Agriculture, Raleigh, N. C.
Brittain, W. H., MacDonald College, Quebec, Canada.
Britton, W. E., Agricultural Experiment Station, New Haven, Conn.
Broadbent, B. M., 2224 Gentilly Rd. New Orleans, La.
Brooks, F. E., U. S. Bureau of Entomology, French Creek, W. Va.
Brown, Luther, Silver Spring, Md.
Brues, C. T., Bussey Institution, Forest Hills, Boston, Mass.
Bruner, Lawrence, 3033 Deakin Street, Berkeley, Calif.
Bulger, J. W., 423 Dorest Ave., Chevy Chase, Washington, D. C.
*Burgess, A. F., Bur. of Entomology, Melrose Highlands, Mass.
Burke, H. E., Forest Insect Lab., Palo Alto, Calif.
Burrill, A. C., Missouri Resources Museum Com., Jefferson City, Mo.
Busck, August, U. S. National Museum, Washington, D. C.
Butcher, Fred D., Iowa Agricultural College, Ames, Iowa.

Caesar, Lawson, Ontario Agricultural College, Guelph, Canada.
Caffrey, D. J., 10 Court St., Arlington, Mass.
Campbell, R. E., Box 297, Alhambra, Calif.
Carter, Walter, U. S. Bur. of Ent., Twin Falls, Idaho.
Cartwright, W. B., 600 26th St., Sacramento, Calif.
Caudell, A. N., U. S. National Museum, Washington, D. C.
Chamberlin, F. S., Box 239, Quincy, Fla.
Chamberlin, T. R., Forest Grove, Ore.
Chambers, E. L., State Entomologist's Office, Madison, Wisc.
Champlain, A. B., Bureau Plant Industry, Harrisburg, Pa.
Chandler, S. C., Route 5, Carbondale, Ill.
Chapman, R. N., Dept. of Animal Biology, University of Minnesota, Minneapolis, Minn.
Childs, Leroy, Hood River, Ore.
Claassen, P. W., 102 Irving Place, Ithaca, N. Y.
Clausen, C. P., Address unknown
Cleveland, C. R., 910 S. Michigan Ave., Chicago. Ill.
Coad, B. R., U. S. Bureau of Entomology, Tallulah, La.
Cockerell, T. D. A., 809 Tenth St., Boulder, Colo.
Coe, Wesley R., Yale University, New Haven, Conn.

*Life Member.

Colcord, Mabel, Bureau of Entomology, Washington, D. C.
Cole, F. R., 31 Mountain View Ave., Santa Cruz, Calif.
Collins, C. W., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Compton, C. C., Box 12, Aurora, Ill.
Comstock, J. H., Cornell University, Ithaca, N. Y.
Cook, Mel. T., Insular Exp. Station, Rio Piedras, P. R.
Cook, William C., c/o State Entomologist, Bozeman, Mont.
Cooley, R. A., Agricultural Experiment Station, Bozeman, Mont.
Corkins, C. L., Univ. Wyoming, Laramie, Wyo.
Cory, E. N., Agricultural Experiment Station, College Park, Md.
Cotton, R. T., Bureau of Entomology, Washington, D. C.
Craighead, F. C., Bureau of Entomology, Washington, D. C.
Crampton, G. C., Agricultural College, Amherst, Mass.
Crawford, H. G., Entomological Branch, Ottawa, Can.
Creel, C. W., University of Nevada, Reno, Nev.
Criddle, Norman, Treesbank, Manitoba, Can.
Crosby, C. R., Cornell University, Ithaca, N. Y.
Crossman, S. S., Bureau of Entomology, Melrose Highlands, Mass.
Crumb, S. E., Box 346, Clarksville, Tenn.
Culver, J. J., Florida Agr. Supply Co., Orlando, Fla.
Cutright, C. R., Agricultural Experiment Station, Wooster, Ohio.

Davidson, William, Vienna, Va.
Davis, I. W., Danielson, Conn.
Davis, J. J., Agricultural Experiment Station, Lafayette, Ind.
Dean, George A., Kansas State Agricultural College, Manhattan, Kan.
DeLong, Dwight M., Ohio State University, Columbus, Ohio.
De Ong, E. R., 300 Entomology Bldg., Univ. California, Berkeley, Calif.
Detwiler, J. D., 844 Hellmuth Ave., London, Ontario.
Dietz, H. F., 3225 Boulevard Pl., Indianapolis, Ind.
Doane, R. W., Stanford University, Calif.
Dohanian, S. M., 42 Cedar St., Somerville, Mass.
Doucette, C. F., Exp. Station, Puyallup, Washington.
Douglass, J. R., Box 353, Estancia, New Mexico.
Downes, W., Dominion Entomological Lab., Dept. Agriculture, Victoria, B. C
Dozier, H. L., Agricultural Experiment Station, Newark, Del.
Drake, C. J., Iowa State College, Ames, Iowa.
Dudley, J. E., Jr., Experiment Station, Madison, Wisc.
Dunnam, E. W., Boll Weevil Laboratory, Florence, S. C.
Dusham, E. H., College Heights, State College, Pa.

Eckert, J. E., Dept. of Ent., University of Wyoming, Laramie, Wyo.
Eddy, C. O., Clemson College, S. C.
English, Lester L., State Entomology Bldg., Urbana, Ill.
Ellington, G. W., Silver Spring, Md.
Essig, E. O., University of California, Berkeley, Calif.
Evenden, J. C., Coeur D'Arlene, Idaho.
Ewing, H. E., U. S. National Museum, Washington, D. C.
Eyer, J. R., Dep't of Biology, State College, New Mexico.

Fackler, H. L., Knoxville, Tenn.
Faxon, Richard, State House Annex, Columbus, Ohio.
Felt, E. P., State Museum, Albany, N. Y.
Fenton, F. A., 1013 Mills Bldg, El Paso, Texas.
Fernald, H. T., Agricultural College, Amherst, Mass.
Ferris, G. F., Stanford University, Calif.
Fink, D. E., Biology Dept., Univ. of Penn., Philadelphia, Pa.
Fisher, C. K., Box 297, Alhambra, Calif.
Fisher, W. S., U. S. National Museum, Washington, D. C.
Fleming, W. E., Box 69, Riverton, N. J.
Flint, W. P., 1006 S. Orchard St., Urbana, Ill.
Fluke, C. L., University of Wisconsin, Madison, Wis.
Folsom, J. W., Tallulah, La.
Forbes, S. A., University of Illinois, Urbana, Ill.
Ford, A. L., Extension Division, Brookings, S. D.
Fox, Henry, Box H, Moorestown, N. J.
Fracker, S. B., Federal Horticultural Board, Washington, D. C.
Franklin, H. J., East Wareham, Mass.
Freeborn, S. B., University of California, Davis, Calif.
Friend, R. B., Agr. Exp. Stat., New Haven, Conn.
Frison, T. H., Dept. Entomology, Natural History Building, Urbana, Ill.
Frost, S. W., Research Laboratory, Arendtsville, Pa.
Fullaway, D. T., Agricultural Experiment Station, Honolulu, H. T.
Fulton, B. B., Iowa State College, Station A., Ames, Iowa.

Gable, Chas. H., Pleasanton, Texas.
Garman, H., Agricultural Experiment Station, Lexington, Ky.
Garman, Philip, Agricultural Experiment Station, New Haven, Conn.
Gentner, L. G., 352 Marshall Street, East Lansing, Mich.
Gibson, Arthur, Entomological Branch, Ottawa, Canada.
Gillette, C. P., Agricultural Experiment Station, Fort Collins, Colo.
Glasgow, Hugh, Agricultural Experiment Station, Geneva, N.Y.
Glasgow, R. D., University of Illinois, Urbana, Ill.
Glenn, P. A., Office of State Entomologist, Urbana, Ill.
Goodwin James C., Gainesville, Fla.
Goodwin, W. H., North Lima, Ohio.
Graf, J. E., Bureau of Entomology, Washington, D. C.
Graham, S. A., School of Forestry and Conservation, U. of Michigan, Ann Arbor, Michigan.
Granovsky, A. A., 1532 University Ave., Madison, Wisc.
Guyton, T. L., Bureau of Plant Industry, Harrisburg, Pa.

Hadley, C. H., 615 Front Street, Toledo, Ohio.
Hagan, H. R., 949 Webster Street, Palo Alto, Calif.
Hall, M. C., Division of Zoology, Bureau Animal Industry, Washington, D. C.
Hambleton, J. I., 423 Dorset Ave., Chevy Chase, Washington, D. C.
Hamilton, C. C., Rutgers College, New Brunswick, N. J.
Hamlin, J. C., Dept. of Zool. and Ent., Station University, Columbus, Ohio.
Hargreaves, Ernest, Land and Forest Dept., Freetown, Sierra Leone, W. Africa.

*Harned, R. W., A. and M. College, Miss.
Harris, H. M., Zool. Dept., I. S. C., Ames, Iowa.
Hartzell, Albert, Boyce Thompson Inst., 1086 No. Broadway, Yonkers, N. Y.
Hartzell, F. Z., Agricultural Experiment Station, Geneva, N. Y.
Haseman, Leonard, Agricultural Experiment Station, Columbia, Mo.
Hawley, I. M., 473 Fourth Ave., Salt Lake City, Utah.
Hayes, W. P., Department of Entomology, University of Illinois, Urbana, Ill.
Headlee, T. J., Agricultural Experiment Station, New Brunswick, N. J.
Herbert, F. B., Los Gatos, Calif.
Herms, W. B., University of California, Berkeley, Calif.
Herrick, Glenn W., Cornell University, Ithaca, N. Y.
High, M. M., Gulfport, Miss.
Hill, C. C., 227 Moreland Ave., Carlisle, Pa.
Hinds, W. E., Louisiana State University, Baton Rouge, La.
Hine, J. S., Ohio State University, Columbus, Ohio.
Hodgkiss, H. E., Old Experiment Stat. Bldg., State College, Pa.
Hoffman, William A., School of Tropical Medicine, San Juan, P. R.
Hoffmann, W. E., Dept. Biology, Lingnan University, Honglock, Canton, China.
Holland, W. J., Carnegie Museum, Pittsburgh, Pa.
Holloway, T. E., 8203 Oak St., New Orleans, La.
Hood, C. E., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Hooker, W. A., States Relation Service, Washington, D. C.
Hopkins, A. D., 1708 Washington Ave., Parkersburg, W. Va.
Horsfall, J. L., 1086 No. Broadway, Yonkers, N. Y.
Horton, J. R., 126 So. Minneapolis Ave., Wichita, Kan.
Hough, W. S., Winchester, Va.
Houghton, C. O., Agricultural Experiment Station, Newark, Del.
Houser, J. S., Agricultural Experiment Station, Wooster, Ohio.
Howard, C. W., 604 Ohio Street, Wheaton, Illinois.
Howard, L. O., U. S. Bureau of Entomology, Washington, D. C.
Howard, Neale F., 121 West Eleventh Ave., Columbus, Ohio.
Howell, P. A., 2036 East 22nd Street, Cleveland, Ohio.
Huber, L. L., Experiment Station, Wooster, Ohio.
Huckett, H. C., R. F. D., Calverton, N. Y.
Hungerford, H. B., University of Kansas, Lawrence, Kan.
Hunter, S. J., University of Kansas, Lawrence, Kan.
Hutson, J. C., Royal Botanic Gardens, Peradeniya, Ceylon.
Hutson, Ray, Agr. Exp. Station, New Brunswick. N. J.
Hyslop, J. A., U. S. Bureau of Entomology, Washington, D. C.

Illingworth, J. F., Bishop Museum, Honolulu, H. T.
Isely, Dwight, 3 N. Duncan St., Fayetteville, Ark.

Jacobson, W. C., 1341 43rd Street, Sacramento, Calif.
Jaenicke, Alex. J., U. S. Forest Service, Portland, Ore.
Jewett, H. H., Agricultural Experiment Station, Lexington, Ky.
Johannsen, O. A., Box 48, College of Agriculture, Ithaca, N. Y.
Johnson, S. A., Agricultural Experiment Station, Fort Collins, Colo.

---

*Life Member.

Jones, C. R., Agricultural College, Fort Collins, Colo.
Jones, D. W., U. S. Bureau of Entomology, Arlington, Mass.
Jones, P. R., Apart. 102, 100 Kenmore No., Los Angeles, Calif.
Jones, T. H., U. S. Bureau of Entomology, Melrose Highlands, Mass.

Kellogg, V. L., National Research Council, 21 and B Sts., Washington, D. C.
Kelly, E. G., Agricultural College, Manhattan, Kan.
Kennedy, C. H., Ohio State University, Columbus, Ohio.
Kimball, H. H., Agricultural College, Miss.
Kincaid, Trevor, University of Washington, Seattle, Wash.
King, J. L., Box H., Moorestown N. J.
King, K. M., Entomological Laboratory, Saskatoon, Sask., Canada.
King, W. V., Mound, La.
Kinsey, A. C., University of Indiana, Bloomington, Ind.
Kirk, H. B., 1902 North St., Harrisburg, Pa.
Kisliuk, Max, 134 S. 2d St., Philadelphia, Pa.
Knight, H. H., Iowa State College, Ames, Iowa.
Knull, J. N., 1120 N. 17th St., Harrisburg, Pa.
Kotinsky, J., 5154 Parkside Ave., Philadelphia, Pa.

Laake, E. W., Box 208, Dallas, Texas.
Lamson, G. H., Jr., Agricultural College, Storrs, Conn.
Lane, Merton C., Box 448, Toppenish, Wash.
Langford, G. S., Dep't of Ent., Fort Collins, Colorado.
Langston, J. M., Agricultural College, Miss.
Larrimer, W. H., U. S. Bureau of Entomology, Washington, D. C.
Larson, A. O., Box 297, Alhambra, Calif.
Lathrop, F. H., Cherryfield, Me.
Leach, B. R., Box H., Moorestown, N. J.
Leiby, R. W., Department of Agriculture, Raleigh, N. C.
Leonard, M. D., Roberts Hall, Ithaca, N. Y.
Lewis, H. C., Cal. Dept of Agric., Sacramento, Calif.
List, G. M., Agricultural College, Fort Collins, Colo.
Lockwood, Stewart, Entomological Laboratory, Billings, Mont.
Loftin, U. C., Tlahualilo, Estado Durango, Mexico.
Lowry, Philip R., Durham, N. H.
Lowry, Q. S., 2378 Washington St., Canton, Mass.
Lunginbill, Philip, Box 359, Monroe, Mich.
Lyle, Clay, A. and M. College, Miss.

Mackie, D. B., State Insectary, Sacramento, Calif.
MacLeod, G. F., Old Experiment Stat. Bldg., State College, Pa.
Maheux, George, Department of Agriculture, Quebec, Canada.
Manter, J. A., Connecticut Agricultural College, Storrs, Conn.
Marcovitch, S., University Farm, Knoxville, Tenn.
*Marlatt, C. L., U. S. Bureau of Entomology, Washington, D. C.
Mason, A. C., Box 340, Honolulu, H. T.
Mason, P. W., Bureau of Entomology, Washington, D. C.
Matheson, Robert, Cornell University, Ithaca, N. Y.

---

*Life Member.

Maxson, Asa C., Longmont, Colo.
McClendon, S. E., 212 South Hansell Street, Thomasville, Ga.
McColloch, J. W., Agricultural Experiment Station, Manhattan, Kan.
McDaniel, Eugenia, Agricultural College, East Lansing, Mich.
McIndoo, N. E., 7225 Blair Rd., Takoma Park, Washington, D.C.
McIntyre, H. L., Conservation Commission, Albany, N. Y.
McLaine, L. S., Entomological Branch, Ottawa, Can.
Melander, A. L., College of the City of New York, N. Y.
Merrill, G. B., Gainesville, Fla.
Merrill, J. H., Raynham, Mass.
Metcalf, C. L., University of Illinois, Urbana, Ill.
Metcalf, Z. P., Agricultural Experiment Station, West Raleigh, N. C.
Mickel, C. E., University Farm, St. Paul, Minn.
Millen, F. E., Department of Apiculture, Guelph, Canada.
Miller, A. E., 1004 Garfield Ave., Urbana, Ill.
Mitchell, T. B., Department of Agriculture, Raleigh, N. C.
Montgomery, J. H., State Plant Board, Gainesville, Fla.
Moore, William, c/o American Cyanamid Co., 511 5th Ave., New York, N. Y.
Morgan, A. C., U. S. Bureau of Entomology, Clarksville, Tenn.
Morgan, H. A., Agricultural Experiment Station, Knoxville, Tenn.
Morrill, A. W., 1434 Winchester Ave., Glendale, Calif.
Morrison, Harold, U. S. Bureau of Entomology, Washington, D. C.
Morse, A. P., Wellesley, Mass.
Mosher, Edna, Adelphi College, Brooklyn, N. Y.
Mote, D. C., Oregon Agricultural College, Corvallis, Ore.
Moznette, G. F., Box 761, Thomasville, Ga.
Muesebeck, C. F. W., U. S. Bureau of Entomology, Melrose Highlands, Mass.

Neiswander, C. R., Oak Harbor, Ohio.
Nelson, J. A., Mt. Vernon, Ohio.
Ness, Henry, 821 Kellogg St., Ames, Iowa.
Neuls, J. D., 342 Walnut St., Riverside, California.
Newcomer, E. J., Box 243, Yakima, Wash.
Newell, Wilmon, State Plant Commission, Gainesville, Fla.
Noble, W. B., Box 95, West Lafayette, Ind.
Nolan, Willis J., 423 Dorset Ave., Chevy Chase Sta., Washington, D. C.
Nougaret, R. L., Fontana, Calif.

O'Kane, W. C., Agricultural Experiment Station, Durham, N. H.
Osborn, Herbert, Ohio State University, Columbus, Ohio.
Osborn, H. T., 1952 Concord Rd., Columbus, Ohio.
Osburn, Raymond C., Ohio State University, Columbus, Ohio.
Osgood, W. A., New Hampshire Univ., Durham, N. H.

Packard, C. M., Box 95, West Lafayette, Ind.
Paddock, F. B., 535 Hayward Ave., Ames, Iowa.
Painter, H. R., Box 95, West Lafayette, Ind.
Park, O. W., Science Bldg., Ames, Iowa.
Parker, H. L., Le Mont Fenouillet, Hyeres, Var, France.
Parker, J. R., Agricultural Experiment Station, Bozeman, Mont.

Parker, R. R., U. S. Public Health Service, Hamilton, Mont.
Parks, T. H., Dept. of Ent. and Zool., Ohio State University, Columbus, Ohio.
Parman, D. C., Uvalde, Texas.
Parrott, P. J., Agricultural Experiment Station, Geneva, N. Y.
*Patch. Edith M., Experiment Station, Orono, Me
Patch, L. H., Box 283, Sandusky, Ohio.
Peairs, L. M., Agricultural Experiment Station, Morgantown, W. Va.
Pierson, H. B., Dept. Forestry, Augusta, Me.
Pellett, F. C., Hamilton, Ill.
Pemberton, C. E., Hawaiian Sugar Planters' Exp. Station, Honolulu, H. T.
Penny, D. D., Calif. Spray Chemical Co. Watsonville, Calif.
Peterson, Alvah, Entomology Building, Bureau of Entomology, Riverton, N. J.
Pettit, Morley, Georgetown, Ontario, Canada.
Pettit, R. H., Agricultural Experiment Station, East Lansing, Mich.
Phillips, E. F., Cornell University, Ithaca, N. Y.
Phillips, W. J., U. S. Bureau of Entomology, Charlottesville, Va.
Phipps, Clarence R., Experiment Station, Orono, Me.
Pierce, W. D., Box 57, Banning, Calif.
Plank, H. K., Central Jaronú, Prov. Camaguey, Cuba.
Poos, F. W., Virg. Truck Exp. Station, Norfolk, Va.
Popenoe, C. H., U. S. Bureau of Entomology, Washington, D. C.
Porter, B. A., Bureau of Entomology, Washington, D. C.

Quaintance, A. L., U. S. Bureau of Entomology, Washington, D. C.
Quayle, H. J., University of California, Riverside, Calif.

Rea, George H., Reynoldsville, Pa.
Readio, Philip A., Univ. of Kansas, Lawrence, Kansas.
Reed, W. D., 712 Elizabeth Street, Fresno, Calif.
Reeves, George I., 473 4th Ave., Salt Lake City, Utah.
Regan, W. S., Calif. Spray Chemical Co., Yakima, Wash.
Reinhard, H. J., Agr. Exp. Stat., College Station, Texas.
Richardson, C. H., Bureau of Entomology, Washington, D. C.
Richmond, E. A., Box H., Moorestown, N. J.
Riley, W. A., University Farm, St. Paul, Minn.
Robinson, J. M., Experiment Station, Auburn, Ala.
Rockwood, L. P., U. S. Bureau of Entomology, Forest Grove, Ore.
Rohwer, S. A., Bureau of Entomology, Washington, D. C.
Rosewall, O. W., State University, Baton Rouge, La.
Ross, W. A., Vineland Station, Ontario, Canada.
Ruggles, A. G., University Farm, St. Paul, Minn.
Rumsey, W. E., Agricultural Experiment Station, Morgantown, W. Va.
Runner, G. A., U. S. Ent. Lab., Sandusky, Ohio.
Ryan, H. J., 330 No. Broadway, Los Angeles, Calif.

Safro, V. I., Box H, Moorestown, N. J.
Sanders, G. E., c/o Ansbacher Chemical Co., 527 5th Ave., New York City.
Sanders, J. G., c/o Sun Oil Co., Philadelphia, Pa.
Sanders, P. D., College Park, Md.

---

*Life Member.

Sanderson, E. D., Cornell University, Ithaca, N. Y.
Sanford, H. L., Bureau of Entomology, Washington, D. C.
Sasscer, E. R., U. S. Bureau of Entomology, Washington, D. C.
Satterthwait, A. F., Ivanhoe Place, Webster Groves, Mo.
Scammell, H. B., Toms River, N. J.
Schoene, W. J., Agricultural Experiment Station, Blacksburg, Va.
Schweiss, G. S., State Quarantine Office, Reno, Nevada.
Seamans, H. L., Ent. Lab., Lethbridge, Alberta.
Searles, E. M., 1532 University Ave., Madison, Wisc.
Sechrist, E. L., 423 Dorset Ave., Chevy Chase, Washington, D. C.
Severin, H. C., Agricultural Experiment Station, Brookings, S. D.
Severin, H. H., College of Agriculture, Univ. of Calif., Berkeley, Calif.
Shafer, G. D., 321 Melville Ave., Palo Alto, Calif.
Shelford, V. E., Vivarium Bldg., University of Illinois, Champaign, Ill.
Sherman, Franklin, Dept. of Entomology, Clemson College, S. C.
Siegler, E. H., U. S. Bureau of Entomology, Washington, D. C.
Simanton, F. L., Drawer 359, Monroe, Mich.
Simmons, Perez, 712 Elizabeth Street, Fresno, Calif
Smith, F. F., Greenhouse Insect Laboratory, Willow Grove, Pa.
Smith, H. S., Citrus Experiment Station, Riverside, Calif.
Smith, L. B., Box H, Moorestown, N. J.
Smith, M. R., State Plant Board, A. and M. College, Miss.
Smith, R C., Agricultural College, Manhattan, Kan.
Smith, R. H., Citrus Experiment Station, Riverside, Calif.
Smulyan, M. T., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Snapp, O. I., Bureau of Entomology, Fort Valley, Ga.
Snyder, T. E., U. S. Bureau of Entomology, Washington, D. C.
Spencer, Geo. J., Dept. Zoology, Univ. of Toronto, Toronto, Canada.
Spencer, Herbert, Experiment Station, Baton Rouge, La.
Spuler, Anthony, Agricultural Experiment Station, Pullman, Wash.
Stafford, E. W., Agricultural College, Miss.
Stahl, C. F., Tropical Plant Research Found., Central Baragua, Baragua, Cuba.
Stear, J. R., 586 Lincoln Way East, Chambersburg, Pa.
Stearns, L. A., 713 Center Street, Ironton, Ohio.
Stirrett, G. M., Ent. Laboratory, Chatham, Ontario, Canada.
Stockwell, C. W., Box H., Moorestown, New Jersey.
Strand, A. L., Div. Entomology, Univ. Minn., St. Paul, Minn.
Strickland, E. H., University of Alberta, Edmonton, Canada.
Strong, Lee A., Dept. of Agriculture, Sacramento, Calif.
Sullivan, K. C., Agricultural Experiment Station, Columbia, Mo.
Summers, J. N., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Swain, A. F., Box 250, Arcade Station, Los Angeles, Calif.
Swaine, J. M., Entomological Branch, Ottawa, Canada.
Swenk, M. H., 1410 No. 37th St., Lincoln, Neb.
Swezey, O. H., Hawaiian Sugar Planters' Experiment Station, Honolulu, H. T.
Swingle, H. S., Box 416, Fort Valley, Ga.
Symons, T. B., Agricultural Experiment Station, College Park, Md.

Thomas, F. L., College Station, Texas.
Thomas, W. A., Chadbourn, N. C.

Thompson, B. G., 303 Agriculture Hall, Corvallis, Ore.
Timberlake, P. H., Citrus Experiment Station, Riverside, Calif.
Titus, E. G., 1228 Bryan Ave., Salt Lake City, Utah.
Trimble, F. M., Camp Hill, Cumberland Co., Pa.
Troop, James, Agricultural Experiment Station, Lafayette, Ind.
Turner, W. F., Box 822, Macon, Ga.

Underhill, G. W., W. T. Hood Co., Ginter Park, Richmond, Va.
Urbahns, T. D., Department of Agriculture, 1015 L St., Sacramento, Calif.

Vance, A. M., 10 Court St., Arlington, Mass.
Van Dine, D. L., Central Baragua, Baragua Camagney Province, Cuba.
Van Duzee, E. P., Academy Sciences, San Francisco, Calif.
Van Dyke, E. C., University of California, Berkeley, Calif.
Van Leeuwen, E. R., Box H, Moorestown, N. J.
Van Zwaluwenberg, R. H., H. S. P. A. Experiment Station, Honolulu, H. T.
Vickery, R. A., 205 Beardsley Ave., Stratford, Conn.
Viereck, H. L., 1365 Clinton Ave., Newark, N. J.
Vorhies, Chas. T., University Station, Tucson, Ariz.

Wade, J. S., U. S. Bureau of Entomology, Washington, D. C.
Wade, Otis, Univ. of Nebraska, Lincoln, Neb.
Wadley, F. M., University Farm, St. Paul, Minn.
Wakeland, C. C., Entomological Field Station, Parma, Idaho.
Walden, B. H., Agricultural Experiment Station, New Haven, Conn.
Wallace, F. N., 132 State House, Indianapolis, Ind.
Walton, W. R., U. S. Bureau of Entomology, Washington, D. C.
Watson, J. R., Gainesville, Fla.
Webb, J. L., U. S. Bureau of Entomology, Washington, D. C.
Webber, R. T., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Webster, R. L., State College, Pullman, Wash.
Weigel, C. A., Federal Horticultural Board, Washington, D. C.
Weiss, H. B., 19 N. 7th Ave., Highland Park, New Brunswick, N. J.
Weldon, G. P., 420 East D Street, Ontario, Calif.
Wellhouse, Walter, Iowa Agricultural College, Ames, Iowa.
Wheeler, W. M., Bussey Institution, Forest Hills, Mass.
Whelan, Don B., Dept. Entomology, Univ. Nebraska, Lincoln, Nebr.
Whitcomb, W. D., 82 Plympton St., Waltham, Mass.
White, W. H., Bureau of Entomology, Washington, D. C.
Wildermuth, V. L., Entomological Laboratory, Tempe, Ariz.
Willard, H. F., Box 340, Honolulu, H. T.
Williams, C. B., Amani Research Inst. Tanga, Tanganyika Territory, East Africa.
Wilson, H. F., University of Wisconsin, Madison, Wis.
Woglum, R. S., Calif. Fruit Growers' Exchange, Los Angeles, Calif.
*Wolcott, G. N., Box 175, Port-au-Prince, Haiti.
Wood, W. B., U. S. Federal Horticultural Board, Washington, D. C.
Woods, W. C., Kent School, Kent, Conn.
Worthley, H. N., Old Exp. Stat. Bldg., State College, Pa.
Worthley, L. H., 12 So. Market Street, Room 50, Boston, Mass.

---

*Life Member.

Yothers, W. W., U. S. Bureau of Entomology, Orlando, Fla.
Young, M. T., Tallulah, La.
Yuasa, Hachiro, Institute of Entomology, Kyoto Imperial Univ., Kyoto, Japan.

Zappe, Max P., Agricultural Experiment Station, New Haven, Conn.
Zetek, James, Ancon, Canal Zone, Panama.

Total number of Active Members, 455.

ASSOCIATE MEMBERS

Adair, H. S., Box 209, Brownwood, Texas.
Alcazar, Manuel, Escuela de Agricultura, C. Juarez, Chih, Mexico.
Allen, Norman, Exp. Station, Baton Rouge, La.
Abercrombie, H. T., 321 William St., Wichita, Kansas.
Amis, Albert H., Apartado 36, Los Moschis, Sinaloa, Mexico.
Amsler, F. P., Box 331, Gulfport, Miss.
Anderson, Edwin J., Penn. State College, State College, Pa.
Anderson, W. E., Baton Rouge, La.
Arbuthnot, K. D., Dept. of Ent., Michigan State College, East Lansing, Mich.
Armstrong, Thomas, Ent. Lab., Vineland Station, Ontario, Canada.
Arnold, R. B., c/o Tobacco By-Prod. & Chem. Corp., Richmond, Va.
Arnold, T. A., 8 Federal Building, El Paso, Texas.
Ashworth, John T., Danielson, Conn.
Atkinson, N. J., University Saskatoon, Sask., Canada.
Atwell, H. C., Room 101, Courthouse, Portland, Ore.

Bailey, I. L., Northboro, Mass.
Bailey, J. B., 406 Morrill Hall, Univ. of Tenn., Knoxville, Tenn.
Baird, A. B., Entomological Branch, Ottawa, Canada.
Baker, Howard, 2303 West Douglas Ave., Wichita, Kansas.
Baker, W. A., Box 208, Dallas, Texas.
Baldwin, R. S., Woodbury, Conn.
Ballou, C. H., Box H., Moorestown, N. J.
Bare, C. O., Box 4583, Tampa, Fla.
Bare, O. S., Clearwater, Nebraska.
Barnes, P. T., 908 Highland Ave., Palmyra, N. J.
Barnes, William, Decatur, Ill.
Bartley, H. N., Ent. Lab., Silver Creek, N. Y.
Beal, J. A., 610 New Medical Bldg., Ashville, N. C.
Benton, Curtis, U. S. Entomological Lab., West Lafayette, Ind.
Berley, J. A., Clemson College, S. C.
Berryhill, I. W., Box 1334, McAllen, Texas.
Beutenmuller, William, Elm St., Tenafly, N. J.
Bibby, F. F., c/o Dr. F. L. Thomas, Dept. Ent., College Station, Texas.
Bissell, Theo. L., Box 271, Barnesville, Ga.
Blaisdell, H. L., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Blissard, T. J., Box 216, Carlisle, Pa.
Bliss, C. I., Box 5171, Stat. B., New Orleans. La.
Bondy, Floyd F., Tallulah, La.
Borden, A. D., Div. Ent., U of Calif., Berkeley, Calif.

Borodin, D. N., 136 Liberty St., New York, N. Y.
Botsford, R. C., Agr. Experiment Station, New Haven, Conn.
Bottel, A. E., Court House, Riverside, California.
Box, Harold E., Agr. Exp. Sta., Tucuman, Argentina, So. America.
Boyce, A. M., Box 165, Riverside, Calif.
Boyd, M. V., Edentown, N. C.
Bradley, G. H., Mound Laboratory, Mound, La.
Breakey, Edward P., Capitol Annex, Madison, Wisc.
Brinley, F. J., Univ. of Penn., Philadelphia, Pa.
Bromley, Stanley W., Amer. Cyanamide Co., 511 Fifth Ave., New York, N. Y.
Brown, R. C., Társ Utca 3, Budapest, Hungary.
Browne, Ashley C., Box 1184, Sacramento, Calif.
Bruce, W. G., Dept. Ent., K. S. A. C., Manhattan, Kansas.
Brunson, M. A., Dept. of Ent., I. S. C. Ames, Iowa.
Bryson, Harry R., K. S. A. C., Manhattan, Kan.
Buck, J. E., Rural Retreat, Va.
Burdette, R. C., Silver Springs, Md.
Burrell, R. W., Box H, Moorestown, N. J.
Butcher, F. G., Belle Plaine, Kansas.
Butler, H. G., Agricultural Experiment Station, Purdue Univ., Lafayette, Ind.
Buys, John L., St. Lawrence University, Canton, N. Y.

Cagle, L. R., Blacksburg, Va.
Campbell, C. F., Hopewell, Pa.
Campbell, F. L., Bureau of Entomology, Washington, D. C.
Carpenter, C. F. G., R. D. 2, Media, Pa.
Carpenter, H. H., State Plant Board, A. & M. College, Miss.
Carroll, Mitchell, F. & M. College, Lancaster, Pa.
Cartwright, O. L., Oswego, S. C.
Cassidy, T. B., Box 1257, Tucson, Ariz.
Cebollero, F. S., Box 117, Rio Piedras, P. R.
Cecil, Rodney, Experiment Station, Geneva, N. Y.
Chaffin, Jeff, Tavares, Fla.
Chamberlin, W. J., Route 3, Corvallis, Oregon.
Chance, O. M., Box 424, W. Jackson, Miss.
Chapman, P. J., Roberts Hall, Ithaca, N. Y.
Chapman, W. W., 134 So. 2nd St., Philadelphia, Pa.
Chistenson, L. D., 473 Fourth Ave., Salt Lake City, Utah.
Clapp, S. C., Mountain Branch Station, Swannanoa, N. C.
Clark, S. W., Dept. of Entomology, I. S. C., Ames, Iowa.
Cleavinger, E. A., 1707 Laramie St., Manhattan, Kansas.
Cockerham, K. L., Box 205, Biloxi, Miss.
Cody, L. R., Hall of Justice, San Jose, Calif.
Collier, R. O., Douglas, Arizona.
Colmer, R. P., Moss Point, Miss.
Cooley, C. E., Box 991, San Juan, Porto Rico.
Cowan, F. T., 1115 First Street, Billings, Mont.
Craig, F. W., 5201 Chambord St., Montreal, P. Q., Canada.
Cressman, A. W., Box 5171, Sta. B., New Orleans, La.
Crowell, M. F., North East, Pa.

Dampf, Alfons, Avenida Insurgentes 171, Mexico, D. F., Mexico.
Daniel, D. M., Experiment Station, Geneva, N. Y.
Daviault, Lionel, 5201 Chambord St., Montreal, P. Q., Can.
Davis, C. N., 105 Whitten Hall, Columbia, Mo.
Davis, E. G., U. S. Ent. Lab., Tempe, Arizona.
Davis, E. W., Box 342, Richfield, Utah.
Davis, M. H., Dept. of Agriculture, Raleigh, N. C.
Dean, M. L., Bureau of Plant Industry, Boise, Idaho.
Decker, G. C., Iowa State College, Ames, Iowa.
DeCoursey, R. M., La. State University, Baton Rouge, La.
Deen, O. T., Picayune, Miss.
Deen, R. B., Tupelo, Miss.
Denberry, E. P., Greenfield, Tenn.
Del Curto, J. M., Department of Agriculture, Austin, Texas.
De La Parelle, H. J., Ga. State Bd. of Ent., Albany, Ga.
Dibble, C. B., Plymouth Ap'ts No. 1, East Lansing, Mich.
Dills, L. E., Inwood, W. Va.
Dirks, C. O., Div. of Biology, U. of M., Orono, Me.
Ditman L. P., U. of Maryland, College Park, Md.
Dixon, J. W., Independence, Calif.
Dodds, Clifford T., 429 No. 8th St., Santa Paula, Calif.
Dove, W. H., Box 359, Monroe, Mich.
Dowden, P. B., Bureau of Entomology, Melrose Highlands, Mass.
Driggers, B. F., Agricultural Experiment Station, New Brunswick, N. J.
Drinnan, D. E., 406 Morrill Hall, U. of Tenn., Knoxville, Tenn.
Drury, C. W., 1714 Metropolitan Bldg., Toronto 2, Canada.
Dunavan, David, Clemson College, S. C.
Dustan, A. G., Entomological Branch, Ottawa, Canada.
Dutton, W. C., M. S. C. Dept. of Horticulture, East Lansing, Mich.

Eddy, M. W., 249 W. Louther St., Carlisle, Pa.
Elmore, J. C., Box 297, Alhambra, Calif.
Ewing, K. P., 701 Polk Ave., Houston, Texas.

Fagan, J. F., Bentonville, Arkansas.
Fall, F. L., 300 McKinley St., Salem, Ohio.
Farley, J. N., Kansas State Hort. Society, Hutchinson, Kansas.
Farrar, C. L., Fernald Hall, M. A. C., Amherst, Mass.
Farrar, Edward R., South Lincoln, Mass.
Fattig, P. W., Emory University, Ga., Box 788.
Fey, K. Y., Bur. of Entomology, Kashing, Chekiang, China.
Fitcht, G. A., Purdue Univ., Exp. Sta., W. Lafayette, Indiana.
Filinger, G. A., Ohio Agr. Exp. Station, Wooster, Ohio.
Flanders, S. E., Saticoy, Calif.
Flebut, A. J., c/o General Chem. Co., 201 Sansome St., San Francisco, Calif.
Fletcher, R. K., Box 152 Faculty Exchange, College Station, Texas.
Fleury, A. C., c/o State Department of Agriculture, Sacramento, Calif.
Fowler, W. A., 262 Hillcrest Drive, Toronto, Ont.
Frost, H. L., Arlington, Mass.
Fulton, G. R., Grenada, Miss.

Gaines, J. C., Jr., Ent. Dept., College Station, Texas.
Gaines, R. C., Tallulah, La.
Galligan, C. F., 710 N. Roach St., Porterville, Calif.
Gambrell, F. L., Experiment Station, Geneva, N. Y.
Gardner, Theo. R., c/o American Consulate, Yokohama, Japan.
Garrison, Gwynn L., Bureau of Entomology, Washington, D. C.
Garthside, Stanley, Div. of Ent., Univ. Farm, St. Paul, Minn.
Gates, L. M., 5342 Madison Ave., Lincoln, Nebr.
Gay, G., Box 991, San Juan, Porto Rico.
Gibson, L. E., 964 Main St., Melrose Highlands, Mass.
Gilmore, J. U., Box 346, Clarksville, Tenn.
Ginsburg, J. M., Agricultural Experiment Station, New Brunswick, N. J.
Glance, Grace E., Bur. of Entomology, Washington, D. C.
Glover, L. C., Theta U. House, Durham, N. H.
Good, Henry G., Alabama Polytechnic Institute, Auburn, Ala.
Grady, A. G., Bristol, Pa.
Grady, H. J., 209 Clark Ave., Augusta, Ga.
Graham, C., 964 Main Street, Melrose Highlands, Mass.
Gram, Ernest, Statens Plantspatologiske, Lyngby, Denmark.
Grant, D. H., 246 W. 14th St., New York, N. Y.
Graves, F. W., Jr., 402 Atlantic Ave., Boston, Mass.
Gray, G. P., c/o Amer. Cyanamid Co., Azusa, Calif.
Gray, John, College of Agr., Univ. Fla., Gainesville, Fla.
Gray, W. L., Box 162, Natchez, Miss.
Green, C. E., Limoneira Ranch, Santa Paula, Calif.
Green, E. C., 1101 W. Green St., Urbana, Ill.
Griffin, E. L., Food, Drug and Insecticide Admin., Washington, D. C.
Grimes, D. W., Leland, Miss.
Grimes, M. L., Route No. 1, Meridian, Miss.
Griswold, Grace Hall, Dept. Entomology, Cornell Univ., Ithaca, N. Y.
Grossman, E. R., Exp. Station, Gainesville, Fla.
Grube, W. M., 5409 East 25th Street, Kansas City, Mo.
Gui, H. L., Agr. Exp. Station, Wooster, Ohio.
Guild, I. T., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Gunderson, A. J., c/o Sherwin-Williams Co., Cleveland, Ohio.
Guyton, F. E., 110 Miller Ave., Auburn, Ala.

Haack, T. T., c/o Sun Oil Co., Toledo, Ohio.
Haber, V. R., Penn. State College, State College, Pa.
Haegele, R. W., Twin Falls, Idaho.
Haeussler, G. J., Box H, Moorestown, N. J.
Haley, W. E., Sugar Experiment Station, 8200 Oak St., New Orleans, La.
Hall, D. G., Dept. Ent., U. of Ark., Fayetteville, Arkansas.
Hallock, H. C., Westbury, Long Island, New York
Hambleton, E. J., Ent. Dept., Cornell University, Ithaca, New York
Hamner, A. L., A. & M. College, Miss.
Harman, J. H., 2036 East 22nd St., Cleveland, Ohio.
Harman, S. W., Exp. Stat., Geneva, New York.
Harlan, W. R., Chem. Dept., I. S. C., Ames, Iowa.

Harris, J. A., N. C. Department of Agriculture, Raleigh, N. C.
Harrison, P. K., Box 415, Picayune, Miss.
Hartnack, Hugo, 20 East Jackson Boulevard, Chicago, Ill.
Hassan, A. S., Facous, Egypt.
Hawkins, J. H., Agr. Exp. Station, Orono, Me.
Hawkins, Kenneth, c/o G. B. Lewis Co., Watertown, Wis.
Henerey, W. T., Clemson College, S. C.
Hering, P. E., 600 West 113th, New York City.
Herr, E. A., 128 West Lane Ave., Columbus, Ohio.
Hertzog, P. H., Hightstown, N. J.
Hervey, G. E. F., Cornell University, Ithaca, N. Y.
Hester, J. G., Box 1, Agricultural College, Miss.
Hill, A. C., 3193 Portis Ave., St. Louis, Mo.
Hills, O. A., 19th & Polks Street, Corvallis, Oregon.
Hines, Chesley, Yazoo City, Miss.
Hobbs, Edward, Box 233, Rice, Tex.
Hodgson, B. E., 10 Court St., Arlington, Mass.
Hoerner, J. L., Agr. Experiment Station, Fort Collins, Colo.
Hofer, George, Box 1658, Tucson, Ariz.
Hoke, Gladys, A. and M. College, Miss.
Holbrook, J. E. R., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Holdaway, F. G., Div. of Ent., Univ. Farm. St. Paul, Minn.
Hollister, W. O., c/o Davey Tree Experts, Kent, Ohio.
Hottes, F. C., 707 N. 7th St., Grand Jct., Colo.
Houston, Howard, Calif. Spray Chemical Co., Watsonville, Calif.
Howard, S., c/o Huff, Daland Dusters, Inc., Monroe, La.
Hudson, G. H., Plattsburgh, N. Y.
Hull, F. M., Substation 3, Angleton, Texas.

Ingram, J. W., Crowley, La.
Irish, C. F., 418 E. 105th St., Cleveland, Ohio.

Jaynes, H. A., Box H, Moorestown, New Jersey.
Johnson, A. C., 1013 Mills Building, El Paso, Tex.
Johnson, K. W., Archer, Iowa.
Johnson, J. Peter, Box H., Moorestown, N. J.
Johnston, H. B., Wellcome Laboratories, Khartoum, Sudan.
Jones, E. T., 126 S. Minneapolis Ave., Wichita, Kansas.
Jones, M. P., B. and Z. Bldg., Ohio State Univ., Columbus, Ohio.
Jones, S. C., Ent. Dep't, I. S. C., Ames, Iowa.
Jones, W. W., 1328 Spruce St., Berkeley, Calif.

Kamal, Mohamed, Cotton Research Branch, Giza, Egypt.
Keck, Chester B., 724 Kearney St., Manhattan, Kansas.
Keen, F. P., 423 Jordan Hall, Stanford Univ., Palo Alto, Calif.
Keen, Sadie E., Forest Grove, Oregon.
Keenan, W. N., Entomological Branch, Ottawa, Canada.
Keler, Stefan, Pantswowy Institute, Nankowo-Rolniczy, Bydgoszaz, Poland.
Kelley, R. W., 63 West Amelia Ave., Orlando, Fla.
Kellogg, C. R., c/o Fukien University, Foochow, China.

Kellogg, E. S., Box 552, Santa Barbara, Calif.
Kelsheimer, E. G., Oak Harbor, Ohio.
Kidder, Nathaniel T., Milton, Mass.
Kile, H. J., 406 Morrill Hall, Knoxville, Tenn.
Kingwill, H. M., Box 366, Orlando, Calif.
Kirkpatrick, A. F., 178 N. Alta Vista Ave., Monrovia, Calif.
Kislanko, J. P., Ocean Springs, Miss.
Knight, Hugh, Box 111, Glendora, Calif.
Knowlton, G. F., Utah Experiment Station, Logan, Utah.
Kraus, E. J., Univ. of Chicago, Chicago, Ill.

Lacroix, D. S., 1224 W. Jefferson Street, Sandusky, Ohio.
Laing, G. B., 124 D St., Marysville, Calif.
Lange, Richard C., 319 West Side Ave., Webster Groves, Mo.
Lauderdale, J. L. E., Box 368, Yuma, Ariz.
Lawson, P. B., 635 Main St., Lawrence, Kans.
Ledyard, E. M., U. S. Smelting Co., Salt Lake City, Utah.
Lee, J. E., Box 295, Poplarville, Miss.
Lewis, C. W., 10 Court St., Arlington, Mass.
Lipp, J. W., 228 E. Upsal St. Gtn., Philadelphia, Pa.
Little, V. A., Box 225, Main Bldg. College Station, Texas.
Liu, Chung Lo, Tsing Hua College, Peking, China.
Livingston, B. P., Dept. Agr., Montgomery, Ala.
Lyon, S. C., Box 491, Davidson, N. Carolina.

MacAloney, H. J., Northest Forest Experiment Station, Amherst, Mass.
Macdougall, Alice P., Address unknown.
Marshall, James, Dept. of Ent., O. A. College, Guelph, Can.
Martin C. H., P. O. Box 351, Albany, Ga.
Martin, J. F., Bureau Plant Industry, Washington, D. C.
Marvin, G. E., 1532 University Ave., Madison, Wis.
Mathewson, A. A., Waterville, Ohio.
McAllister, L. C., Jr., Box H, Moorestown, N. J.
McBride, O. C., Box 491, Orlando, Fla.
McCampbell, S. C., Zool Bldg, C. A. C., Fort Collins, Colo.
McDonnell, C. C., U. S. Bureau of Chemistry, Washington, D. C.
McDonough, F. L., Niagara Sprayer Co., Middleport, N. Y.
McDowell, O. S., Cal. Spray Chemical Co., 204 Franklin St., N. Y. C
McEvilly, J. E., Box 297, Laurel, Miss.
McEvoy, J. A., 136 Church St., Putnam, Conn.
McGehee, T. F., Holly Springs, Miss.
McGinnis, G. R., 710 No. 15th St., Corvallis, Ore.
McKay, R. S., Batavia, Ohio.
McKinney, K. B., Box 346, Clarksville, Tenn.
McLean, R. R., County Building, San Diego, Calif.
McPhail, Miyanoato, Box 295, Weslaco, Texas.
Meacham, F. B., State College, Raleigh, N. C.
Melvin, Roy, 136 Campus Ave., Ames, Iowa.
Menagh, C. S., U. S. Bureau of Entomology, Washington, D. C.
Mendenhall, E. W., 97 Brighton Rd., Columbus, Ohio.

Merino, Gonzala, c/o Bureau of Agriculture, Manilla, P. I.
Merril, D. E., 5th and Sycamore St., Rogers, Ark.
Metzger, F. W., Box H, Moorestown, N. J.
Millar, J. A., 36 Charles St., Wakefield, Mass.
Millar, P. H., State Plant Board, Little Rock, Ark.
Miller, R. L., Dep't of Ent., O. S. U., Columbus, Ohio.
Mills, A. S., 206 Fairmont Ave., Ithaca, N. Y.
Mills, James, Jr., Hamilton, Glen Co., Calif.
Milton, Jack, Box 194, Corinth, Miss.
Milum, V. G., 104 Vivarium Bldg., Champaign, Ill.
Mitchener, A. V., Manitoba Agricultural College, Winnipeg, Canada.
Moreland, R. W., Tallulah, Miss.
Morofsky, Walter F., 328 Grove St., East Lansing, Mich.
Morris, E. L., 812 E. First St., Santa Ana, Calif.
Mortenson, E., Box 509, Uvalde, Texas.
Moser, J. C., 205 Prospect Place, Brooklyn, N. Y.
Moulton, Dudley, 244 California St., San Francisco, Calif.
Munro, J. A., State College, Fargo, N. D.
Murray, M. A., 1708 Washington Ave., Parkersburg, W. Va.

Nakayama, Shonosuke, Agr. Exp. Sta. of Gov't. General of Corea, Suigen, Corea.
Neil, F. A., Room 50, 12 So. Market St., Boston, Mass.
Neiswander, R. B., Ent. Dep't, O. S. U., Columbus, Ohio.
Nelson, F. C., 414 Chestnut St., Roselle Park, N. J.
Newbegin, I. B., Wakefield, Mass.
Newton, J. H., Paonia, Colo.
Nichol, A. A., Agr. Exp. Sta., Tucson, Ariz.
Nickels, C. B., U. S. Bureau of Entomology, Washington, D. C.
Nickolsky, V. V., Moscow Tropical Institute, Moscow, Russia.
Norris, R. K., Exp. Station, Talent, Oregon.

O'Dell, J. H., Box 1857, Phoenix, Ariz.
Ohlendorf, Walter, Tlahualilo, Durango, Mexico.
Orton, W. A., 1350 B St., S. W., Washington, D. C.
Osburn, M. R., Box H, Moorestown N. J.
Osterberger, B. A., Agr. Exp. Station, Baton Rouge, La.
Owen, W. L., c/o Dr. F. L. Thomas, College Station, Texas.
Ozburn, R. H., Department of Entomology, Guelph, Ont.

Pack, H. J., Agr. Exp. Sta., Logan, Utah.
Painter, R. R., K. S. A. C., Manhattan, Kans.
Parker, J. B., 1217 Lawrence St., N. E., Washington, D. C.
Parker, Ralph L., K. S. A. C., Manhattan, Kans.
Parker, W. B., Cal. Spray Chemical Co., Placerville, Calif.
Parks, H. B., Route E, Box 368, San Antonio, Texas.
Partridge, N. L., Box 133, Paw Paw, Mich.
Peets, N. D., Box 144, Brookhaven, Miss.
Pepper, J. O., Clemson College, S. C.
Peters, H. S., 363 W. 9th Ave., Columbus, Ohio.

Phillips, Saul, Conservation Commission, Albany, N. Y.
Pierstorff, A. L., Agr. Exp. Station, New Brunswick, N. J.
Pillsbury, A. E., 17 Division St., Silver Creek, N. Y.
Poe, S. E., State Plant Board, Little Rock, Ark.
Polioka, J. B., 213 Locust St., Oak Harbor, Ohio.
Pope, J. B., c/o Huff Daland Dusters, Inc., Monroe, La.
Potts, S. F., Bur. of Entomology, Melrose Highlands, Mass.
Powell, A. R., 401 W. 118th St., New York, N. Y.
Powers, E. B., Univ. Tennessee, Knoxville, Tenn.
Prevost, E. S., Clemson College, S. C.
Price, R. C., Bedsole-Colvin Drug Co., Mobile, Ala.
Price, W. A., Purdue University, Lafayette, Ind.
Primm, James K., 204 Franklin St., New York, N. Y.
Proper, A. B., 21 Auburn Street, Melrose Highlands, Mass.

Reeher, Max M., Forest Grove, Ore.
Reese, C. A., Dept. Agriculture, Columbus, Ohio.
Reeves, J. A., Box 549, Sanford, Fla.
Reid, W. J., U. S. Bureau of Entomology, Chadbourn, N. C.
Remy, Theron P., The Texas Co., Houston, Tex.
Ressler, I. L., Box 250, Arcade Station, Los Angeles, Calif.
Reynolds, G. D., Exp. Station, Florence, S. C.
Richardson, H. H., Gipsy Moth Laboratory, Melrose Highlands, Mass.
Ries, Donald T., 401 Thurston Ave., Ithaca, N. Y.
Riley, H. K., Dept. Ent., Purdue Univ. Exp. Sta., West Lafayette, Ind.
Roark, R. C., Bur. of Chem., U. S. D. A., Washington, D. C.
Roberts, H. E., 628 Clark Ave., Webster Groves, Mo.
Roberts, Raymond, 902 N. 29th Street, Lincoln, Nebr.
Roberts, R. A., Ent. Dep't. I. S. C., Ames, Iowa.
Robinson, Sid, Clinton, Miss.
Robinson, Wm., 2116 Knapp St., St. Paul, Minn.
Roesling, C. F., Box 250, Arcade Station, Los Angeles, Calif.
Rogers, Leslie, Box 4036, Knoxville, Tenn.
Rolfs, P. H., Viscosa E. F., Leopoldina, Minas Geraes, Brazil.
Roney, J. N., Div. of Ent., College Station, Texas.
Root, E. R., Medina, Ohio.
Ross, T. S., Central Jaronó, Prov. of Camaguey, Cuba.
Roullard, Fred P., 220 Holland Bldg., Fresno, Calif.
Rounds, M. B., 521 N. Michigan Ave., Glendora, Calif.
Rude, C. S., Extension Entomologist, Stillwater, Okla.
Ruffin, W. A., Box 247, Auburn, Ala.
Russell, E. E., Ent. Lab., Tempe, Ariz.
Russo, Giuseppe, Estación Nacional Agronomica, Moca (Rep. Dominicana), Porto Rico.
Ryberg, M. E., c/o Boyce Thompson Instit. Plant Research, Yonkers, New York.

Salman, K. A., 82 Pleasant St., Amherst, Mass.
Sams, C. L., State College Sta., Raleigh, N. C.
Savage, J. R., Agri. Exp. Sta., Wooster, Ohio.

Sazama, R. F., 2 East Locust St., Vincennes, Ind.
Schaffner, J. V., Jr., Melrose Highlands, Mass.
Schenk, Gilbert, 4917 Broadway, Kansas city, Mo.
Schlosberg, Morris, 998 Bedford Ave., Brooklyn, New York.
Schlupp, W. F., Newcomerstown, Ohio.
Scott, L. B., 17 Division St., Silver Creek, N. Y.
Scott, L. M., 6510 Ridgwood Ave., Chevy Chase, Washington, D. C.
Scott, W. M., 518 Oak Ave., Sanford, Fla.
Scullen, H. A., Agricultural College, Corvallis, Ore.
Seeley, R. M., Box 201, Arondale Estates, Ga.
Sellers, W. F., 51 Clifford St., Melrose, Mass.
Sheaffer, F. E., 3814 Park Ave., Indianapolis, Ind.
Sheldon, H. B., Santa Paula, Calif.
Sheppard, R. W., P. O. Box 35, Niagara Falls, Ont.
Sherman, Franklin, College Station, Texas.
Shirk, F. H., Box 448, Toppenish, Wash.
Shiver, J. C., Box 592, Charlottsville, Va.
Shoemaker, A.I., Bur. of Entomology, Washington, D. C.
Shotwell, R. L., Billings, Mont.
Smith, Charles E., Experiment Station, Baton Rouge, La.
Smith, F. A., Senatobia, Miss.
Smith, G. A., State Forester's Office, State House, Boston, Mass.
Smith, G. E., Albion, N. Y.
Smith, G. L., Delta Laboratory, Tallulah, La.
Smith, H. D., Kronenberg Building, Carlisle, Pa.
Smith, W. F., 152 S. Lake Ave., Pasadena, Calif.
Snow, S. J., 473 4th Ave., Salt Lake City, Utah.
Soliman, L. B., Dep't of Ent., Savoy Hotel Bldg., Cairo, Egypt.
Sorenson, C. J., Agricultural Experiment Station, Logan, Utah.
Spangenberg, Herbert, 137 N. San Joaquin St., Stockton, Calif.
Spangler, A. J., Matador School, Matador, Texas.
Speaker, H. J., 534 E. Monroe St., Sandusky, Ohio.
Spooner, Charles, 1508 S. 3d St., Charleston, Ill.
Spruijt, F. J., 816 Kohl Bldg., San Francisco, Calif.
Steenburg, W. E., 670 E. Maiden St., Washington, Penn.
Steiner, L. F., Agr. Exp. Station, Lafayette, Ind.
Stene, A. E., Kingston, R. I.
Stevenson, W. A., Box 1257, Tucson, Ariz.
Stewart, M. A., Dept. of Biology, Univ. of Rochester, Rochester, N. Y.
St. George, R. A., Entomological Laboratory, E. Falls Church, Va.
Stiles, C. F., Box 37, Stillwater, Okla.
Stone, M. W., 309 Aztec Bldg., San Antonio, Texas.
Stone, W. E., Box 549, Sanford, Fla.
Sutton, F. J., Fort Valley, Ga.
Sweetman, H. L., Agr. Exp. Sta., Laramie, Wyoming.
Symonds, C. M., 17 E. Highland Ave., Melrose Hlds., Mass.

Talbert, T. J., Whitten Hall, Columbia, Mo.
Thomas, C. A., Penn State College Lab., Bustleton, Philadelphia, Pa.

Thompson, W. L., Lake Alfred, Fla.
Thomson, J. R., Jr., Univ. Tenn., Knoxville, Tenn.
Tippit, W. A., San Benito, Texas.
Tissot, A. N., Experiment Station, Gainesville, Fla.
Todd, F. E., State Insectary, Capitol Park, Sacramento, Calif.
Todd, J. N., Iowa State College, Ames, Iowa.
Tolles, G. S., Phylean House, East Lansing, Michigan.
Toyne, Arthur, 112 E Ave. 41, Los Angeles, Calif.
Tubbs, D. W., 511 West 19th Street, Santa Ana, Calif.
Turner, C. K., Auburn, Placer Co., Calif.
Turner, Neely, Aurora, Mo.

Ulman, P. T., European Corn Borer Control, Auburn, Ind.

Vansell, G. H., University Farm, Branch College of Agriculture, Davis, Calif.
Vaughan, E. A., Box 4044, Tampa, Fla.
Vickery, R. K., Rayfield, Loom Lane, Radlett, Herts, England.

Wagner, G. B., Dep't Ent., K. S. A. C., Manhattan, Kan.
Walkden, H. H., 126 S. Minneapolis Ave., Wichita, Kan.
Walker, H. G., 208 E. Northwood Ave., Columbus, Ohio.
Wall, R. E., 905 East Ninth St., Pueblo, Colo.
Wallace, C. G., Sardis, Mississippi.
Wallis, R. L., Clemson College, S. C.
Walsh, S. G., Moquelumne Club, Lodi, Calif.
Walter, E. V., U. S. Entomological Laboratory, San Antonio, Tex.
Wardle, R. A., Univ. Farm, St. Paul, Minn.
Weed, Alfred, Dept. of Ent. U. of W., Madison, Wisc.
Weed, C. M., State Normal School, Lowell, Mass.
Wehrle, L. P., Roberts Hall, Ithaca, N. Y.
Wells, A. B., Alicia, Saginaw Co., Mich.
West, L. S., Battle Creek College, Battle Creek, Mich.
Wheeler, A. J., Madison, Tenn.
Wheeler, C. M., University of Tenn., Knoxville, Tenn.
Whitcomb, Warren, 1532 University Ave., Madison, Wisc.
Whitehead, T. E., University of Idaho, Moscow, Idaho.
Whitmarsh, R. D., Lake Winnemissett, Deland, Fla.
Wilcox, Joseph, 2638 Jackson St., Corvallis, Oregon.
Willey, C. R., Room 1112, State Office Bldg., Richmond, Va.
Williams, G. R., Durant, Miss.
Williams, V. E., Glendora, Calif.
Williams, V. V., Box 1222, Calexico, Calif.
Williamson, Warren, R. D. 5, Galesburg, Ill.
Wilson, C. C., 600 26th, St., Sacramento, Calif.
Winchester, H. I., U. S. Bureau of Entomology, Melrose Highlands, Mass.
Winter, J. D., University Farm, St. Paul, Minn.
Woodhams, G. E., 510 Lemar Ave., Azusa, Calif.
Woodruff, L. C., Entomology Laboratory, Charlottesville, Va.
Woodworth, H. E., 2237 Carlton St., Berkeley, Calif.
Wooldridge, Reginald, U. S. Bureau of Entomology, Melrose Highlands, Mass.

Worthington, G. I., Box 175, Cleveland, Miss.
Wymore, Floyd H., University Farm, Davis, Calif.

Yeomans, M. S., Cornelia, Ga.
York, C. H., 136 East Artesia St., Pomona, Calif.
Young, H. C., Box 1257, Tucson. Ariz.

Zeimet, Carlo, Bureau of Entomology, Washington, D. C.
Total Number of Associate Members, 472.

FOREIGN MEMBERS

Anderson, T. G., Nairobi, British East Africa.
Aulló Costilla, Dr. Manuel, Laboratorio de la Fauna Forestal Espanola, Ferraz, 40 Madrid, Spain.

Ballou, H. A., West Indian Agricultural College, St. Augustine, Trinidad, West Indies.
Bordage, Edmond, Directeur de Musee, St. Denis, Reunion.
Brain, Charles K., University of Stellenbosch, Stellenbosch, C. P. South Africa.

Carpenter, Dr. George H., University of Manchester, Manchester, England.
Collinge, W. E., 55 Newhall St., Birmingham, England.

Danysz, J., Laboratorie de Parasitologie, Bourse de Commerce, Paris, France.
DeBussy, L. P., Kolonial Instit., Mauritskade 65–66, Amsterdam, Holland.

Escherisch, K., Forstliche Versuchsaustalt, Universitat, Munich, Germany.

French, Charles, Department of Agriculture, Melbourne, Australia.
Froggatt, W. W., 12 Young St., Croyden, Sydney, New South Wales.
Fuller, Claude, Division of Entomology, Box 513, Pretoria, South Africa.

Goding, F. W., Box 448, Livermore Falls, Maine, U. S. A.
Grasby, W. C., 6 West Australian Chambers, Perth, West Australia.
Green, E. E., Way's End, Beach Ave., Camberley, Surry, England.

Herrera, A. L., Director de Estudios, Bibliogicas, Secretaria de Agricultura y For mento, Mexico, D. F. Mexico.
Hill, Gerald F., 5 Clifton Rd., Hawthorn, Melbourne, Australia.
Horvath, Dr. G., Museum Nationale Hungaricum, Budapest, Hungary.

Jablonowski, Josef, Entomological Station, Budapest, Hungary.
Jack, Rupert W., Salisbury, Rhodesia, South Africa.
Johnson, Thomas H., University of Brisbane, Queensland, Australia.

Kulagin, Nikolai M., Petrovsky-Rasumovsky Academy, Petrovsko-Rasumovskoie, Moscow, Russia.
Kuwana, S. I., Imperial Agricultural Experiment Station, Yokohama, Japan.

Lea, A. M., National Museum, Adelaide, South Australia.
Lounsbury, Charles P., 795 Church St. East, Pretoria, South Africa.

Mally, C. W., University of Stellenbosch, Stellenbosch, C. P., South Africa.
Marchal, Dr. Paul, 16 Rue Claude-Bernard, Paris, France.

Mokrzecki, Dr. Sigismond, Director, Instit. of Forest Protection and Entomology, Skierniewice, Poland.
Mussem, Charles T., Hawkesbury Agricultural College, Richmond, New South Wales.

Nawa, Yashushi, Entomological Laboratory, Kyomachi, Gifu, Japan.
Newstead, Robert, University School of Tropical Medicine, Liverpool, England.

Porter, Carlos E., Casilla 2352, Santiago, Chili.
Pospielow, Dr. Waldemar, Bureau of Entomology, Morskaya 44, Petrograd, Russia.

Reed, Charles S., Mendoza, Argentine Republic, South America.
Ritzema Bos, Dr. J., Wageningen, Holland.
Rosenfeld, A. H., Am. Sugar Cane League, 1005 New Orleans Bank Bldg., New Orleans, La.

Sajo, Prof. Karl, Godollo-Veresegyhaz, Hungary.
Schoyen, Prof. W. M., Zoological Museum, Christiana, Norway.
Severin, Prof. G., Curator Natural History Museum, Brussels, Belgium.
Silvestri, Dr. F., R. Scuola Superiore di Agricoltura, Portici, Italy.
Stellwagg, Dr. Friedrich, Neustadt, A. d. Haardt, Germany.

Theobald, Frederick V., Wye Court, Wye, Kent, England.
Thompson, Rev. Edward H., Franklin, Tasmania.
Tillyard, R. J., Cawthron Institute of Scientific Research, Nelson, New Zealand.
Tragardh, Ivor, Experimental Faltat, Stockholm, Sweden.
Tryon, H., Queensland Museum, Brisbane, Queensland, Australia.

Urich, F. W., Department of Agriculture, Port of Spain, Trinidad, West Indies.

Total number of Foreign Members, 48
Grand Total of Members, 975.

Forty-First Annual Meeting
of the
American Association of Economic Entomologists
New York, N. Y.
December 27 to 31, 1928

Forty-First Annual Meeting of the American Association of Economic Entomologists, New York, N. Y.

December 27 to 31, 1928

The 41st annual meeting of the American Association of Economic Entomologists will be held at New York, N. Y., on the above-named dates. The meeting of the Section of Plant Quarantine and Inspection will be held Thursday, December 27. The Extension Entomologists and Insect Pest Survey will hold a meeting in a separate room, starting at 3 P. M.

The opening business session of the general Association and address of the President will be held Friday morning, followed by reading of papers through the remainder of that session and the afternoon. Reading of papers before the general Association will continue through Saturday. Starting at 9:30 A. M., that day, the Section of Apiculture will hold its meeting in a separate room. The Entomologists' Dinner will be held at 5:30 P. M. Saturday in the American Museum of Natural History. No sessions have been scheduled for Sunday. The A. A. A. S. has arranged for excursions and entertainments, the details of which will be announced at the meeting. Reading of papers will continue through the morning session on Monday and the meeting will conclude with a final business session in the afternoon. This Association and its Sections will meet in the Gymnasium, Thompson Hall, Teachers College, Columbia University, 120th and Broadway. The Extension Entomologists and Insect Pest Survey session will be held at Macy Hall, Teachers College.

Sectional Meetings

The meeting of the Section of Plant Quarantine and Inspection will be held at 9:30 A. M. Thursday and will continue until 3 P. M. The meeting of the Section of Apiculture will be held at 9:30 A. M. Saturday.

Other Meetings

The annual meeting of the American Association for the Advancement of Science, its sections and associated societies, will be held December 27, 1928 to January 2, 1929.

The Entomological Society of America will open its meeting on Thursday morning, December 27, and will continue through Friday, December 28. The annual public address before that society will be delivered by Dr. R. N. Chapman, University of Minnesota, on Friday evening at 8 o'clock. Members of this Association are especially invited to attend this session.

The Extension Entomologists and Insect Pest Survey will hold a meeting on Thursday, December 27, at 3 P. M. The Crop Protection Institute will probably have an evening meeting, the details of which will be announced later.

Hotel Headquarters

The McAlpin Hotel, Broadway and 34th Street, will be headquarters for this Association and the Entomological Society of America. Rates as follows:

Single rooms, running water	$2.75
Single rooms, with bath	4.00
Rooms (accommodating two to four) running water	$2.00 to $2.50 per person
Rooms (accommodating two to four) with bath	$2.25 to $2.50 per person
Outside (double) rooms, with bath,	$3.00 to $3.25 per person

Railroad Rates

Practically all railroads offer reduced fares to the meeting of the A. A. A. S. Members should secure a certificate when purchasing tickets, stating that they are attending the meeting of the American Association for the Advancement of Science; leave the certificate at the registration room for endorsement and validation, and present the certificate when purchasing return ticket to secure one-half regular fare for the return trip. A charge of $1.00 will be made for validation.

Entomologists' Dinner

The entomologists' dinner will be held at the Flying Bird Hall, American Museum of Natural History, on Saturday evening, December 29, at 5:30 o'clock. All entomologists are cordially invited to attend.

Membership

Applications for membership can be secured from the Secretary or from the Committee on Membership. These should be filled out, properly endorsed, and filed with the Membership Committee on or before December 29. Each application must be accompanied with fee of $4.00 to cover dues and subscription to the JOURNAL for the year following election.

Exhibits

Members are requested to make exhibits of appliances, apparatus, photographs, maps or models demonstrating life history or control methods in preventing insect damage. Such exhibits will be displayed in Thompson Hall, Teachers College, near the meeting room. Those wishing to send exhibits should do so in advance and should correspond directly with Dr. William Moore. c/o American Cyanamid Company, 535 Fifth Avenue, New York City, who is in charge of local arrangements for the Association.

A. A. A. S.—Membership

Special privilege is granted this year to all our members to join the American Association without payment of the usual entrance fee. Application cards are available through the Secretary of that organization.

Program

SECTION OF PLANT QUARANTINE AND INSPECTION

L. S. McLAINE, *Chairman* S. B. FRACKER, *Secretary*

Thursday Morning Session, December 27, 9:30, Gymnasium, Thompson Hall, Teachers College

Address by the Chairman, L. S. McLaine, Ottawa, Canada.

1. Report of the National Plant Board. L. A. Strong, Sacramento, Calif.
2. REPORTS OF THE REGIONAL BOARDS:
   The Eastern Plant Board. T. J. Headlee, New Brunswick, N. J.
   The Southern Plant Board. R. W. Harned, A. & M. College, Miss.
   The Central Plant Board. F. N. Wallace, Indianapolis, Ind.
   The Western Plant Quarantine Board. M. L. Dean, Boise, Idaho.
3. Recent Developments in Federal Plant Quarantine Activities. C. L. Marlatt, Washington, D. C.
4. Preventing the Spread of the Japanese and Asiatic Beetles. C. H. Hadley, Jr., Camden, N. J.

5. European Corn Borer Quarantine Work. L. H. Worthley, Toledo, Ohio.

6. The Present Status of Gipsy Moth, Brown-tail Moth and Satin Moth Control. A. F. Burgess, Melrose Highlands, Mass.

Program

Thursday Afternoon Session, December 27, 2:00

7. A Brief Summary of Fruit Fly Surveys in Argentine, Spain and the Canary Islands. Max Kisliuk, Jr., Philadelphia, Pa.

8. Forest Diseases of Recent Introduction:
    (a) The Woodgate Rust. H. H. York, Albany, N. Y.
    (b) The European Larch Canker in America. Haven Metcalf, Washington, D. C.

9. Bulb Diseases in Europe. F. L. Drayton, Ottawa, Canada.

10. The Subjects of Important State quarantines:
    (a) Raspberry Mosaic. J. D. Winter, St. Paul, Minn.
    (b) Alfalfa Weevil and the Alfalfa Meal Industry. W. H. Larrimer, Washington, D. C. and G. I. Reeves, Salt Lake City, Utah.

    Survey of history and scientific basis of Alfalfa Weevil quarantines. Introducing recent research on Alfalfa Meal as means of spreading pest.

    (c) Present Status of Potato Wart Disease Eradication. W. A. McCubbin, Harrisburg, Pa.
    (d) The Present Status of the Sweet Potato Weevil in the United States. R. W. Harned, A. & M. College, Miss.
    (e) The Citrus Canker. K. F. Kellerman, Washington, D. C.
    (f) Changes needed in Oriental Fruit Moth Quarantines. J. M. Del Curto, Austin, Texas.

11. Recent Interceptions of Plant Pests. E. R. Sasscer, Washington, D. C.

Reports of Committees.

Selection of Officers.

Adjournment.

Program

MEETING, EXTENSION ENTOMOLOGISTS AND INSECT PEST SURVEY

Thursday, December 27, 3 P. M.,
Room 119, Macy Hall, Teachers College

P. D. **Sanders**, *Chairman* G. F. **MacLeod**, *Secretary*

Committee Reports.
Appointment of Committees.

Program

READING OF PAPERS AND DISCUSSIONS

1. Some Essentials in the Training of Extension Entomologists. L. O. Howard, Washington, D. C.
2. Administrative Phases of Teaching, Research, Regulatory and Extension Entomology. T. J. Headlee, New Brunswick, N. J.
3. Extension Entomology in Relation to Research Entomology. V. I. Safro, Moorestown, N. J.
4. The Insect Pest Survey. J. A. Hyslop, Washington, D. C.

Report of Nominating Committee.
Election of Officers.
Adjournment.

Program

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Friday Morning Session, December 28, 9:30, Gymnasium,
Thompson Hall, Teachers College

Report of the Secretary.
Report of the Executive Committee, by President W. B. Herms.
Report of the Representative to the National Research Council, by W. A. Riley, St. Paul, Minn.
Report of the Committee on Policy, by R. W. Harned, A. & M. College, Miss.
Report of the Trustees of the Crop Protection Institute, by W. C. O'Kane, Durham, N. H.
Report of Scientific Trustee, Tropical Plant Research Foundation, by Herbert Osborn, Columbus, Ohio.

Report of the Representatives on the Council of the Union of American Biological Societies, by A. L. Quaintance, Washington, D. C.

Report of the Committee on Nomenclature, by J. A. Hyslop, Washington, D. C.

Report of Committee on Endowment, by A. F. Burgess, Melrose Highlands, Mass.

Report of Editorial Board on Index to Economic Entomology, by E. P. Felt, Stamford, Conn.

Report of Board of Trustees for Permanent Fund, by C. W. Collins, Melrose Highlands, Mass.

Report of the Committee on United States National Museum, by W. E. Hinds, Baton Rouge, La.

Report of Program Committee, by C. H. Hadley, Camden, N. J.

Report of Committee to Formulate Plans for Investigation of the Codling Moth from Biologic and Control Standpoints, by A. L. Quaintance, Washington, D. C.

Report of Advisory Committee, Entomologists and Agronomists on Research and Control of European Corn Borer, by George A. Dean, Manhattan, Kansas.

Report of Committee on Insect Pest Survey, by C. R. Crosby, Ithaca, N. Y.

Report of Committee on Recommendations to Secretary of Agriculture with Reference to Needs for Foreign Stations to Study Insect Pests, Plant and Animal Diseases Introduced or Likely to be Introduced, by P. J. Parrott, Geneva, N. Y.

Report of Committee on Training of Entomologists, by W. C. O'Kane, Durham, N. H.

Appointment of Committees.

Miscellaneous Business.

New Business.

Annual Address of the President, W. B. Herms, Berkeley, Calif.

1. The Experimental Method as Applied to Entomological Investigations.

Discussion of the Presidential Address.

READING OF PAPERS

INSECTS AS BIOLOGICAL CONTROLS

2. Factors Affecting the Feeding Rate of Rodolia cardinalis (Muls.). (5 min.) (Lantern.) A. W. Cressman, New Orleans, La.

Measures of the influence of natural factors on feeding rate.

3. The 1928 Work with *Trichogramma* for Control of the Sugarcane Borer. W. E. Hinds and Herbert Spencer, Baton Rouge, La. (5 min.) (Lantern.)

The artificial hibernation, propagation and distribution of *Trichogramma minutum* Riley in fields of corn and sugarcane during 1928 on a rather large scale have confirmed the encouraging results obtained in 1927, and indicate possible usefulness of this procedure for field control of the Sugarcane Borer, (*Diatraea saccharalis* Fabr.).

Program

Friday Afternoon Session, December 28, 1:30

READING OF PAPERS

INSECTS AFFECTING DECIDUOUS FRUITS

4. Further Observations on the Use of Chemically Treated Codling Moth Bands. (5 min.) E. A. Siegler, Washington, D. C. and Luther Brown, M. A. Yothers and W. P. Yetter, Jr., Fort Collins, Colo.

This paper includes some of the principal results and a brief discussion of recent tests conducted under different climatic conditions.

5. A Laboratory Method for Determining the Attractiveness of Bands to Codling Moth Larvae. (5 min.) (Lantern.) C. R. Cutright and J. S. Houser, Wooster, Ohio.

The method is described and some results obtained by its use are given.

6. Codling Moth Baits in Southern Indiana. (5 min.) L. F. Steiner, Lafayette, Indiana.

The results of 1927 experiments with a large variety of fermenting and chemical baits and of a practical large scale test with the best of these in 1928.

·7. Miscellaneous Codling Moth Studies. (5 min.) L. F. Steiner, Lafayette, Ind.

8. The Unsprayed Check Tree as an Indicator of Seasonal Codling Moth Activity. (5 min.) W. S. Regan, Yakima, Wash.

Frequent thinning (about 10 day intervals) throughout the season, of an unsprayed tree, for worms and "Stings," throws some interesting light on worm activity.

9. A Determination of the Lethal Dosage of Arsenic for Missouri and Colorado Codling Moth Larvae. (5 min.) By Leonard Haseman and V. F. Burk, Columbia, Mo.

Worms from Colorado and worms taken at Columbia, Missouri, of like sizes, weights and ages were fed measured quantities of arsenic and the Missouri worms showed greater resistance to the poison than did those from Colorado.

10. Further Studies on the Relative Resistance to Arsenical Poisoning of Codling Moth Larvae. (5 min.) (Lantern.) W. S. Hough, Winchester, Va.

A comparison of Colorado, Virginia and Washington codling moth larvae.

11. Observations on the Oil-Nicotine Combination for the Control of Codling Moth and other Apple Insects in the Pacific Northwest. (5 min.) F. B. Herbert, San Francisco, Calif. and M. D. Leonard, Louisville, Ky.

Two years of experimental work in the Pacific Northwest indicates that a combination of oil and nicotine may have an important place in the apple spray program. Satisfactory and economical control of codling moth and the other more important apple insects has been obtained and the spray residue problem simplified.

12. A Field Test of the Effect of Artificial Light on the Behavior of the Codling Moth, *Carppcapsa pomonella.* (5 min.) (Lantern.) W. B. Herms, Berkeley, Calif.

Electric lights were suspended over a block of trees, consisting of mixed varieties of apples. The plot was flooded with light each evening for about two hours from April 26 to June 30. Temperature records were kept and foot candle meter readings were made of the light intensities. Trees of the same variety showed a smaller percentage of wormy apples in the lighted area than those without.

13. An Operation in Practical Control of Codling Moth in a Heavily Infested District. (5 min.) (Lantern.) T. J. Headlee, New Brunswick, N. J.

This paper is an account of the third and final year and shows still further increase in fruit free from codling moth injury.

14. Preliminary Report on Attrahents for Peach Insects. (5 min.) O. I. Snapp and H. S. Swingle, Fort Valley, Ga.

Listing a number of chemicals attracting peach insects.

15. Fourth Contribution to a Study of Baits (with special reference to Oriental Fruit moth). (5 min.) S. W. Frost, Arendtsville, Pa.

The catches from a great variety of baits are summarized and the results of control blocks are given.

16. Hydrated Lime in Summer Sprays for the Control of the Oriental Fruit Moth: A Preliminary Report. (5 min.) (Lantern.) L. A. Stearns and R. B. Neiswander, Ironton, Ohio.

A record of the results of laboratory tests and orchard spraying in Ohio during 1928.

17. Factors that Limit Control Efforts for the Oriental Peach Moth. (5 min.) (Lantern.) Alvah Peterson, Columbus, Ohio.

A general review of the writer's observations and opinions on the possibility and probability of controlling the oriental peach moth. Certain factors, which are frequently overlooked or ignored by investigators, are discussed.

18. Preliminary Tests with Possible Repellents of the Oriental Peach Moth. (5 min.) (Lantern.) J. W. Lipp, Philadelphia, Pa.

Paper describes preliminary methods and materials used. An apparatus for field testing is described.

19. Relation of Snow Cover to Infestation by the Grape Berry Moth (*Polychrosis viteana* Clemens). (5 min.) (Lantern.) F. Z. Hartzell, Geneva, N. Y.

Infestation was found to be closely related to amount of snow cover present during periods of low temperatures; remedial measures are suggested.

20. Life History and Control of the Grape Berry Moth in Delaware. (5 min.) H. L. Dozier and H. G. Butler, Newark, Del.

Records a third brood of worms in Delaware under 1928 conditions and value of late coverage.

21. *Syneda alleni* Grt., a cutworm destructive to blueberry in Maine. (5 min.) C. R. Phipps, Orono, Maine.

Some observations upon the biology, economic importance, and control of *Syneda alleni*, a Maine blueberry pest.

22. Effects of Oil Sprays on the Maturity of Citrus Fruits. (5 min.) (Lantern.) O. G. McBride and W. W. Yothers, Orlando, Fla.

Influence of the oils on the lethal maturity ratio.

23. Seasonal History of the Mexican Fruit Worm (*Anastrepha ludens* L.) in Cuernavaca in 1928. (5 min.) (Lantern.) M. McPhail and C. I. Bliss, Mexico City, Mex.

Results of seasonal history study based on insectary records.

24. The Bud Moth in Western New York. (5 min.) (Lantern.) S. W. Harman, Geneva, N. Y.

Importance of the bud moth in western New York apple orchards and difficulties encountered in securing control of an apple pest, which heretofore has not been regarded as important to the apple industry.

25. Further Results with Fish Oil as an Adhesive. (5 min.) (Lantern.) H. L. Dozier, Newark, Del.

Results briefly of extensive use of fish oil as a sticker in various combinations on apple, grapes and peaches in Delaware during past summer.

Program

Saturday Morning Session, December 29, 9:30

READING OF PAPERS

INSECTS AFFECTING CEREAL, FORAGE AND FIELD CROPS

26. Leafhopper Injury to Legumes. (5 min.) (Lantern.) F. W. Poos, Rosslyn, Va.

A preliminary report on studies pertaining to injuries of forage crop legumes which are caused by leafhoppers; particularly the species responsible for the injury. (Possible disease relationship.)

27. Predicting Outbreaks of *Eutettix tenellus* Baker; the purpose of predictions under present conditions. (5 min.) Walter Carter, Twin Falls, Idaho.

With the development of research on the sugar beet leafhopper problem and with changed agricultural conditions it is desirable to re-state the purposes to be achieved in predicting outbreaks of the insect.

28. *Eutettix tenellus* Baker as a Factor in the Production of Nicotine for Insecticidal Purposes. (3 min.) Walter Carter and R. G. Crawford, Twin Falls, Idaho.

29. Tropisms of the Medican Cotton Boll Weevil (*Anthonomus grandis* Boh.). (Read by title.) E. F. Grossman, Gainesville, Florida.

30. *Eupelmus popa* Girault, a parasite of the Sorghum Midge, *Contarinia sorghicola* Coq. (5 min.) L. C. Woodruff, Lawrence, Kansas.

Observations on the biology with special reference to the feeding habits.

31. Attempts to Protect Sweet Corn from Infestation with the Corn Ear Worm, *Heliothis obsoleta* (Fab.). (5 min.) S. B. Freeborn, Davis, Calif.

Approximately 10,000 individual ears of sweet corn were classified as to their stage of development at the time of treatment with several standard and some new drugs to test the efficacy of these products as insecticides or repellents of the corn ear worm.

EUROPEAN CORN BORER

32. A General Summary of the European Corn Borer Situation in the United States at the Close of 1928. (5 min.) D. J. Caffrey, Arlington, Mass.

A brief report upon the more important developments during 1928.

33. Nutrition as a Factor in the Responses of the European Corn Borer. (5 min.) (Lantern.) J. S. Houser and L. L. Huber, Wooster, Ohio

This paper calls attention to the growing recognition of the fact that European corn borer abundance is greatly determined by the growth condition of the host. The various responses of the insect, such as the rate of spread, the rate of accumulation, the seasonal fluctuation in population and the ultimate saturation point are influenced by the physico-chemical processes of the corn plant.

34. Some Factors Determining Corn Borer Damage. (5 min.) L. H. Patch, Sandusky, Ohio.

Oviposition and mortality of the corn borer are discussed in relation to the date of planting of corn, and also the mortality in relation to type and variety of corn.

35. A Study of the Abundance of *Pyrausta nubilalis* Hubn. in Maize in Southwestern France. (3 min.) H. L. Parker, Hyeres, Var, France.

36. *Pyrausta nubilalis* in Europe; Notes on Infestation and Parasitism from 1926 to 1928. (3 min.) H. L. Parker, Hyeres, Var, France.

MISCELLANEOUS

37. Two Scale Insects, their Biology and Control. (5 min.) G. W. Herrick, Ithaca, N. Y.

38. The More Important Insect Problems of Haiti. (Read by Title.) R. C. Smith, Port-au-Prince, Haiti.

A summary of the principal insects of economic importance in Haiti with brief accounts of their activities and control practised.

39. Insects in Relation to Plant Diseases. (5 min.) A. A. Granovsky Madison, Wisc.

A brief discussion of the role of insects in transmission and dissemination of fungous, bacterial and virous diseases of plants.

40. Application of One of Pearson's Probability Theorems to certain types of Entomological Data. (5 min.) (Lantern.) F. Z. Hartzell, Geneva, N. Y.

The usual method of computing probable errors is not applicable to certain kinds of data. Pearson has developed a theorem which offers a way out of the difficulty.

41. Leaf Hopper Immigrants of Economic Interest. (5 min.) Herbert Osborn, Columbus, Ohio.

Of the many species of leaf hoppers that have migrated into the United States a considerable number have economic importance and it is desirable to determine their source, the means of introduction and the possible methods of exclusion for other species liable to find entrance.

INSECTS AFFECTING ORNAMENTAL PLANTS

42. Effects of Oil Concentration and Population Density on Camphor Scale (*Pseudaonidia duplex*) Control with Oil Emulsions. (5 min.) (Lantern.) C. I. Bliss and A. W. Cressman, New Orleans, La.

Oil concentration and population density as they influence mortality.

43. Observations on the Life Cycle of the Mealybug (*Pseudococcus citri*) as a Pest of Greenhouse Ornamentals. (5 min.) C. A. Weigel, Washington, D. C.

Program

SECTION OF APICULTURE

H. F. WILSON, *Chairman* E. N. CORY, *Secretary*

Saturday Morning Session, December 29, 9:30, Room 125,
Macy Hall, Teachers College

Address by the Chairman, H. F. Wilson, Madison, Wisconsin.

READING OF PAPERS AND DISCUSSIONS

1. The Presence of Wax-globules as a Cause of Cloudiness in Honey. (5 min.) E. L. Sechrist, Washington, D. C.

2. The Effect of Color Classification on the Domestic and Foreign Market. (10 min.) J. I. Hambleton, Washington, D. C.

3. The Yeasts of Honey and How they are Carried by the Honey Bee. (10 min.) H. F. Wilson and G. E. Marvin, Madison, Wisc.

A discussion of the yeasts found in honey and a report on the determination of these yeasts from various parts of the bee.

4. Preliminary Report on Formaldehyde Gas Treatment of American Foulbrood Combs. (10 min.) C. E. Burnside, Washington, D. C.

5. The Respiratory Exchange of the Honey Bee. (5 min.) G. H. Vansell, Davis, Calif.

Notes on amount of carbon dioxide and water produced in the hive.

6. Brood Rearing Cycle of Carniolan Bees. (10 min.) W. J. Nolan, Washington, D. C.

7. Weather and its Influence on Changes in Hive Weight. (10 min.) J. Alex. Munro, Fargo, N. D.

8. The Effects of Moving Bees at Orchard Blooming Time. (10 min.) Ray Hutson, New Brunswick, N. J.

9. Definition of a Commercial Beekeeping Region. (10 min.) E. F. Phillips, Ithaca, N. Y.

10. The Influence of Humidity upon the Sugar Concentration of the Nectar of Various Flowers. (5 min.) O. W. Park, Ames, Iowa.

A positive correlation is shown between humidity of the air and the sugar concentration of the nectar of various flowers.

11. Discussion of a possible Reorganization of the Apiculture Section.

Reports of Committees.

Selection of Officers.

Adjournment.

Program

Saturday Afternoon Session, December 29, 1:30

READING OF PAPERS

INSECTS AFFECTING DECIDUOUS FRUITS

(Japanese and Asiatic Beetles)

44. Effects of Geranium on the Japanese Beetle. (5 min.) C. H. Ballou, Moorestown, N. J.

Japanese beetles feed on geraniums, especially flowers. Paralysis follows, from which many recover.

45. Soil Treatment for Japanese Beetle Control. (5 min.) E. N. Cory and P. D. Sanders, College Park, Md.

Methods of application of carbon bisulphide emulsion, costs and apparent results.

46. Distribution and Abundance in New York of Oriental Beetles, *Anomala orientalis*, *Aserica castanea* and *Serica similis.* (5 min.) (Lantern.) H. C. Hallock, Westbury, L. I., N. Y.

Records include not only the ranges of the insects but notes on their general abundance in the various localities where they occur.

47. A Trap for the Japanese Beetle (*Popillia japonica* Newm.). (5 min.) (Lantern.) E. A. Richmond and F. W. Metzger, Moorestown, N. J.

Four years' experiences relative to the evolution of a trap for the Japanese beetle.

48. Hot Water Treatment of Nursery Plants. (5 min.) W. E. Fleming, Moorestown, N. J.

Data obtained during the past two years indicates that several varieties of plants can be treated successfully to destroy the immature stages of the Japanese beetle.

49. Some Observations on Japanese Beetle Injury. Part I. Unsprayed Communities. (5 min.) V. I. Safro, Trenton, N. J.

Effect of several factors upon food preferences in unsprayed communities.

50. Some Observations on Japanese Beetle Injury. Part II. Sprayed Communities. (5 min.) G. F. MacLeod, State College, Pa.

51. The Control of the Asiatic Beetle in Lawns. (5 min.) (Lantern.) R. B. Friend, New Haven, Conn.

The Asiatic beetle as a lawn pest may be controlled by poisoning the soil with lead arsenate. The poison may be applied as a suspension in water or mixed with a top dressing of loam, or it may be mixed directly in the soil.

52. Methods of Obtaining Emergence of Tiphia Adults from Imported Cocoons for Introduction Against the Japanese Beetle. (5 min.) (Lantern.) H. W. Allen and R. W. Burrell.

After developing and trying nearly a score of different setups for obtaining emergence of Tiphia cocoons, it has been found that incubation in a damp cellar with moisture and humidity control combined with the isolation of the cocoons singly in ventilated glass vials gives excellent results.

INSECTICIDES AND APPLIANCES

53. Variations in Resistance of Aphids to Toxic Sprays. (5 min.) (Lantern.) Neely Turner, New Haven, Conn.

A brief discussion of this subject citing data obtained by very accurate methods to show the differences in resistance of different species to the same spray.

54. A Substitute for Arsenic as an Insecticide. (5 min.) (Lantern.) N. E. McIndoo, Washington, D. C.

Comparative laboratory tests, conducted in 1923 and 1928, on 5 species of larval insects, showed the average toxicities of cuprous cyanide and acid lead arsenate to be the same.

55. Experiments with Talc and Other Dusts Used Against the Larvae of the Oriental and Codling Moths. (5 min.) (Lantern.) B. F. Driggers, New Brunswick, N. J.

Finely ground talc and mica dusts, when dusted lightly on foliage, killed from 90 to 100% of the newly hatched larvae. Ordinary orchard dusts—such as lime and sulfur—killed less than 50% of the larvae under the same conditions.

56. Mercury Salts as Soil Insecticides. (5 min.) (Lantern.) Hugh Glasgow, Geneva, N. Y.

Various salts of mercury have been found to be efficient insecticides for use in the control of certain types of soil-inhabiting insects.

57. Manganese Arsenate as a Control for the Codling Moth. (5 min.) (Lantern.) R. L. Miller, Sanford, Fla.

Progress report giving results of laboratory and field work.

58. The Role of Bordeaux as a Leafhopper Insecticide. (5 min.) (Lantern.) D. M. De Long, Columbus, Ohio.

59. Tolerance of Different Species and Varieties of Plants to Napthalene Vapor. (5 min.) (Lantern.) Albert Hartzell, Yonkers, N. Y.

The tolerance of 150 species and varieties of plants were tested to naphthalene vapor and the effect of this fumigant on red spider and thrips noted.

60. Adherence of Some Dust Materials. (5 min.) D. F. Barnes and S. F. Potts, Melrose Highlands, Mass.

The paper records briefly the results of three years study of the relative adherence of certain insecticide dusts and adhesives. The effect of various meteorological conditions is considered.

61. A Correlation between Oil Sprays and Chlorophyll Content of Foliage. (5 min.) (Lantern.) J. M. Ginsburg, New Brunswick, N. J.

Leaves from apple trees sprayed with 1% oil contained more chlorophyll and exhibited later leaf drop than leaves from trees not sprayed with oil.

62. The Mixture of Oil and Water in Spray Tanks. (5 min.) R. H. Smith, Riverside, Calif.

63. Determining Hydrocyanic Acid Gas Concentration in Fumigation Experiments. (5 min.) (Lantern.) C. O. Eddy and E. N. Geddings, Clemson College, S. C.

64. Recent Progress in the Chemistry of Derris. (5 min.) R. C. Roark, Washington, D. C.

Rotenone, the active principle of *Derris elliptica*, occurs in the root to the extent of about 2½ per cent. The chemical properties and compatabilities of rotenone are described.

65. Weights of Various Fumigants that can be Vaporized in a 1,000 Cubic Foot Fumigating Chamber. (5 min.) (Lantern.) R. C. Roark and O. A. Nelson, Washington, D. C.

A table shows the weights of about thirty fumigants that can be vaporized in a 1,000 cubic foot fumigating chamber at temperatures from 32° to 122° F.

66. The Growth of the Foliage and Fruit of the Apple in Relation to the Maintenance of a Spray Coating. (5 min.) (Lantern.) C. C. Hamilton, New Brunswick, N. J.

Weekly measurements were made to determine the rate of foliage and fruit growth on two varieties of apples. Samples of fruit and foliage were collected at each date of measuring the growth and analyses were made to determine the arsenic they contained. The results cover the period of active growth.

Program

Monday Morning Session, December 31, 9:30

READING OF PAPERS

INSECTS AFFECTING TRUCK CROPS

67. Notes on the Potato Scab Gnat, *Pnyxia scabiei* Hop. (5 min.) (Lantern.) H. L. Gui, Wooster, Ohio.

This paper contains a discussion of the potato scab gnat based upon observations made since 1926. Some of the results of experimental work conducted on this insect are included.

68. A Study of the Digestive Enzymes of the Potato Beetle at varied pH. (5 min.) (Lantern.) D. E. Fink, Philadelphia, Pa.

This study shows the pH range, the optimum activity and type of the digestive enzymes found in the potato beetle.

69. Mexican Bean Beetle. (5 min.) L. M. Peairs, Morgantown, W. Va.

Results of control measures during season of 1928 in West Virginia.

70. Spraying for the Control of Onion Thrips in Massachusetts. (5 min.) A. I. Bourne, Amherst, Mass.

Effective control secured by a combined spray of Fish Oil Soap and Nicotine Sulfate. The development of an effective spray program based on seasonal development of the insect. A new power outfit adapted to field spraying of onions.

71. Onion Maggot Control. (5 min.) (Lantern.) Hugh Glasgow, Geneva, and H. J. Cook, Ithaca, N. Y.

Recent experiences in New York State with different methods for the control of the onion maggot.

72. The Status of the Onion Maggot (*Hylemyia antiqua* Meig.). (5 min.) H. F. Wilson, Madison, Wisc.

The onion maggot has been a very serious pest in Wisconsin and is becoming more so each year. This account deals with its distribution, a historical review of the damage and possible lines of control.

73. A Contribution to the Study of Control Measures for Cucumber Beetles (*Diabrotica duodecempunctata* Oliv. and *vittata* Fabr.). (5 min.) (Lantern.) H. C. Huckett, Riverhead, L. I., N. Y.

This paper presents in brief form an account of studies in the control of cucumber beetles in which special emphasis is laid on ways and means of killing them.

74. Observations on the Carrot Rust Fly (*Psila rosae* Fab.) in Massachusetts. (5 min.) W. D. Whitcomb, Waltham, Mass.

Discussion of seasonal history, habits, host plants and results of preliminary control experiments.

75. The Carrot Rust Fly Problem. (5 min.) Hugh Glasgow, Geneva, and J. G. Gaines, Ithaca, N. Y.

The relative value of cultural methods and insecticides in the control of the Rust fly is considered.

INSECTS AFFECTING FOREST AND SHADE TREES

76. Calosoma Beetle Trap. (5 min.) (Lantern.) C. W. Collins and J. E. R. Holbrook, Melrose Highlands, Mass.

Development of trap for ascertaining population of *Calosoma sycophanta* and incidentally other tree climbing beetles, with possibilities of its use in collecting on a large scale for further colonization against the gipsy moth.

77. The Need for Investigations on Shade Tree Insects. (5 min.) E. P. Felt, Stamford, Conn.

The numerous valuable shade trees of the country, many irreplaceable, amply justify an extensive research program.

INSECTS AFFECTING THE HOUSEHOLD AND STORED PRODUCTS

78. Revival of Plodia Larvae and Oryzaephilus Adults After Commercial Vacuum Fumigation with Carbon Disulphide at Fresno, California, in 1926-27. (5 min.) J. C. Hamlin, Salt Lake City, Utah.

Discussion of the conditions, intervals and percentages of revival of grown Indian-meal moth larvae and saw-toothed grain beetle adults after fumigation with carbon disulphide and carbon dioxide under the general conditions of operation employed at the two commercial vacuum fumigation plants in the San Joaquin Valley of California from August, 1926 to February, 1927.

Film showing Delegates to Fourth International Entomological Congress, also Scenes of Cornell University Campus and Vicinity. J. A. Manter, Storrs, Conn.

FINAL BUSINESS

Report of Committee on Resolutions.
Report of Committee on Membership.
Reports of other committees.
Nomination of JOURNAL officers by advisory committee.
Report of Committee on Nominations.
Election of Officers.
Miscellaneous business.
Fixing the time and place of next meeting.
Final adjournment.

W. B. HERMS, *President*,
Berkeley, Calif.

C. W. COLLINS, *Secretary*,
Melrose Highlands, Mass.

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Proceedings of the Fortieth Annual Meeting of the American Association of Economic Entomologists

The fortieth annual meeting of the American Association of Economic Entomologists was held in North Gymnasium, Y. M. C. A. College, Nashville, Tenn., December 27 to 30, 1927.

The Section of Plant Quarantine and Inspection convened at 9:45 A. M., December 27 and adjourned at 3:35 P. M. Chairman J. H. Montgomery, Gainesville, Fla., presided and in the absence of W. B. Wood, S. B. Fracker, Washington, D. C., acted as Secretary pro tem. The chairman, in his address stressed the importance of quarantine activities and the increasing danger of pest importations under modern transportation conditions. Reports of the Central, Southern and Western Plant Boards and of the National Plant Board showed these organizations to be functioning in the direction of increased efficiency and uniformity in plant quarantine and inspection work. Introducing a symposium on the activities of the Federal Horticultural Board, Dr. C. L. Marlatt described "Recent Developments in Federal Plant Quarantine Work," emphasizing the control operations against the Mexican fruit worm and the cotton pink bollworm. This was followed by papers on "The Present Status of the Pink Bollworm and the Thurberia Weevil" by G. G. Becker; "Narcissus Inspection Problems" by S. B. Fracker and "Mexican Fruitworm Eradication" by A. C. Baker. "Pacific Port Inspection" was described by L. A. Strong, and the results of a "Pear Blight Eradication" program in Arkansas by G. G. Becker. Under the title "Shall the Station Entomologist also direct the State Regulatory Work," Leonard Haseman pointed out the tendency toward the separation of the two types of activities and the advantages and disadvantages of retaining them under the same directing head. After a round table during which developments in the Japanese beetle and gipsy moth problems were discussed informally, L. S. McLaine was elected Chairman and S. B. Fracker secretary for 1928.

The Section of Apiculture convened at 3 P. M. December 27, concluding that evening. Although three other meetings were going on at the same time, this session was characterized by a good attendance and papers which echoed considerable and carefully executed research. No session of this Section has ever been attended by more interest and more representative apiculturists from the United States. Several members of the Tennessee Beekeepers' Association were present and entered into the discussion. Fifty-five were present in the afternoon, and at the round table discussion there were sixteen, making a total attendance of seventy-one. The chairman of this Section for 1928 is H. F. Wilson, and E. N. Cory (College Park, Md.) is Secretary.

The Cotton States Branch held a joint session with the main Association on Thursday afternoon at which time papers dealing with entomological problems in Southern States, including the cotton boll weevil, were presented. This Branch held a short business meeting and adjourned for their meeting at Memphis, Tenn., February 1, 2 and 3.

Section O (Agriculture) held a joint meeting with the American Society of Agronomy and this Association at which meeting there was a symposium on "The Corn Borer Situation." The meeting attracted considerable interest and was well attended. Some interesting discussion was entered into, especially with reference to parasites and the possibility of breeding new resistant varieties of corn.

The program of the main Association opened Wednesday afternoon, with a business session, with President R. W. Harned of A. & M. College, Miss., in the Chair. C. W. Collins, Secretary. Reports of various committees were read, these being followed by the address of the President entitled "Entomology in the Southern States." President Harned gave a most interesting compilation of the development of entomology in the South. The total number of titles of papers submitted for the meeting was 109, which is slightly more than the number scheduled for any previous meeting. More than 80 papers were read at the meetings, including those before the Sections and Branch. There were six papers on the European Corn Borer which attracted considerable attention, lively discussion following their presentation. There was a symposium on insecticides where four entomologists reviewed briefly the development in this field to date. Nine papers under the heading "Insecticides and Appliances" were read, which covered in a measure the interesting developments during the past year in this field. Under the group "Insects Affecting the Household and Stored Products," some interesting papers were presented. At the joint session with the Cotton States Branch, the cotton boll weevil came in for considerable attention and discussion. Two outstanding papers were presented at this session on "The Preparation of a Special Light Sodium Fluosilicate" and "The Preparation of Special Calcium Arsenates Containing Less Than 40% Arsenic as As_2O_5 and their uses as Boll Weevil Poisons," by Capt. H. W. Walker of the Chemical Warfare Service. Among other instructive papers presented were a number on "Insects Affecting Truck Crops" and "Insects Affecting Cereal, Forage and Field Crops," "Insects Affecting Forest, Shade Trees and Ornamental Plants" and "Insects Affecting Deciduous Fruits." New and striking data were presented in connection with the codling moth research work from various sections of the country. There was also an interesting group of papers under the division "Insects Affecting Bulbs, Greenhouse Crops, Tropical and Sub-tropical Plants," treating the developmental history of bulb insects and the hot water treatment for bulbs infested with the Narcissus Bulb Fly.

On Wednesday evening, December 28, the 7th annual entomologists dinner, at the Hotel Hermitage, was held in honor of Dr. L. O. Howard, for 33 years chief of the U. S. Bureau of Entomology. 249 members and guests attended this dinner. Dr. H. A. Morgan, President of the University of Tennessee, acted as toastmaster. The occasion was one of the most pleasing that this Association has enjoyed at their annual conventions. Dr. C. L. Marlatt, the present chief of the Bureau, paid tribute to the work of Dr. Howard, who responded in a most fitting manner. Dr. Howard showed many slides and gave sidelights on his contacts with European entomologists. Dr. F. E. Lutz, President of the Entomological Society of America, was assigned the subject of "Unapplied Entomology" which he treated most ably. Entertainment was furnished by local talent.

The Extension Entomologists and Insect Pest Survey held a meeting Thursday evening at the Hotel Hermitage, which was well attended.

The Crop Protection Institute held its annual dinner and business meeting on Tuesday evening, December 27.

The business proceedings form Part I of this report, and the addresses, papers and discussions form Part II.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by President R. W. Harned at 1:45 P. M., Wednesday, December 28. About 250 members and visitors attended the sessions. The following members were present:

Abbott, W. S., Vienna, Va.
Abercrombie, H. T., New York, N. Y.
Adair, H. S., Brownwood, Texas.
Alden, C. H., Fort Valley, Ga.
Anderson, E. J., State College, Pa.
Arnold, R. B., Richmond, Va.
Baerg, W. J., Fayetteville, Ark.
Bailey, J. B., Knoxville, Tenn.
Baker, A. C., Washington, D. C.
Balduf, W. V., Urbana, Ill.
Ball, E. D., Sanford, Fla.
Barber, E. R., New Orleans, La.
Beal, J. A., Asheville, N. C.
Bentley, G. M., Knoxville, Tenn.
Benton, Curtis, West Lafayette, Ind.
Berger, E. W., Gainesville, Fla.
Bigger, J. H., Jacksonville, Ill.
Bilsing, S. W., College Station, Texas.
Brannon, C. H., Raleigh, N. C.
Brannon, L. W., Birmingham, Ala.
Broadbent, (Miss) Bessie M., New Orleans, La.
Bromley, S. W., New York, N. Y.
Burgess, A. F., Melrose Highlands, Mass.
Butler, H. G., Lafayette, Ind.
Caffrey, D. J., Arlington, Mass.
Cagle, L. R., Blacksburg, Va.
Campbell, F. L., New York, N. Y.
Chamberlin, F. S., Quincy, Fla.
Chambers, E. L., Madison, Wisc.
Chance, O. M., W. Jackson, Miss.
Chandler, S. C., Carbondale, Ill.
Chapman, R. N., St. Paul, Minn.
Collins, C. W., Melrose Highlands, Mass.
Craig, F. W., Morgantown, W. Va.
Crosby, C. R., Ithaca, N. Y.
Davis, J. J., Lafayette, Ind.
Dean, G. A., Manhattan, Kans.
DeCoursey, R. M., Urbana, Ill.
DeLong, D. M., Columbus, Ohio
Dietz, H. F., Indianapolis, Ind.
Dills, L. E., Inwood, W. Va.
Denberry, E. P., Greenfield, Tenn.
Dozier, H. L., Newark, Del.
Drake, C. J., Ames, Iowa
Drinnan, D. E., Knoxville, Tenn.
Eddy, C. O., Clemson College, S. C.
English, L. L., Urbana, Ill.
Ewing, H. E., Washington, D. C.
Fackler, H. L., Knoxville, Tenn.
Faxon, Richard, Columbus, Ohio
Felt, E. P., Albany, N. Y.
Filinger, G. A., Wooster, Ohio
Flint, W. P., Urbana, Ill.
Folsom, J. W., Tallulah, La.
Fracker, S. B., Washington, D. C.
Frison, T. H., Urbana, Ill.
Frost, S. W., Arendtsville, Pa.
Gambrell, F. L., Geneva, N. Y.
Garman, H., Lexington, Ky.
Gibson, Arthur, Ottawa, Can.
Glenn, P. A., Urbana, Ill.
Good, H. G., Auburn, Ala.
Goodwin, J. C., Gainesville, Fla.
Grady, H. J., Augusta, Kans.
Graham, S. A., Ann Arbor, Mich.
Granovsky, A. A., Madison, Wisc.
Gray, John, Gainesville, Fla.
Guyton, F. E., Auburn, Ala.
Guyton, T. L., Harrisburg, Pa.
Haack, T. T., Toledo, Ohio
Hamner, A. L., A. & M. College, Miss.
Harned, R. W., A. & M. College, Miss.
Hartzell, Albert, Yonkers, N. Y.
Haseman, Leonard, Columbia, Mo.
Hawkins, J. H., Orono, Maine.
Hawkins, Kenneth, Watertown, Wisc.
Herrick, G. W., Ithaca, N. Y.
Hinds, W. E., Baton Rouge, La.
Hodgkiss, H. E., State College, Pa.
Holdaway, F. G., Adelaide, Australia
Hollister, W. O., Kent, Ohio.
Horsfall, J. L., Yonkers, N. Y.
Hough, W. S., Winchester, Va.
Houser, J. S., Wooster, Ohio
Howard, L. O., Washington, D. C.

Howard, Neale F., Columbus, Ohio
Howard, Samuel, New Orleans, La.
Hungerford, H. B., Lawrence, Kans.
Hyslop, J. A., Washington, D. C.
Isely, Dwight, Fayetteville, Ark.
Jewett, H. H., Lexington, Ky.
Jones, M. P., Columbus, Ohio
Kennedy, C. H., Columbus, Ohio
Kile, H. J., Knoxville, Tenn.
King, K. M.,Saskatoon, Canada
Kinsey, A. C., Bloomington, Ind.
Langston, J. M., Agricultural College, Miss.
Larrimer, W. H., Washington, D. C.
Lawson, P. B., Lawrence, Kans.
Leiby, R. W., Raleigh, N. C.
Loftin, U. C., Tlahualilo, Mexico
Lyle, Clay, A. & M. College, Miss.
Marcovitch, S., Knoxville, Tenn.
Marlatt, C. L., Washington, D. C.
Martin, C. H., Albany, Ga.
Marvin, G. E., Madison, Wisc.
Mathewson, A. A., Toledo, Ohio
McAlister, L. C., Jr., Moorestown, N. J.
McBride, O. C., Orlando, Fla.
McCampbell, S. C., Fort Collins, Colo.
McColloch, J. W., Manhattan, Kans.
McEvilly, J. E., Laurel, Miss.
McKay, R. S., Owenville, Ohio
McLaine, L. S., Ottawa, Can.
McPhail, Miyanoato, Ames, Iowa
Metcalf, C. L., Urbana, Ill.
Metcalf, Z. P., West Raleigh N. C.
Mickel, C. E., St. Paul, Minn.
Millar, P. H., Little Rock, Ark.
Millen, F. E., Guelph, Canada
Miller, R. L., Lake Alfred, Fla.
Montgomery, J. H., Gainesville, Fla.
Moore, William, New York, N. Y.
Morgan, A. C., Clarkesville, Tenn.
Ness, Henry, Ames, Iowa
Newell, Wilmon, Gainesville, Fla.
Nolan, Willis J., Washington, D. C.
O'Kane, W. C., Durham, N. H.
Osborn, Herbert, Columbus, Ohio
Osborn, H. T., Columbus, Ohio
Osburn, R. C., Columbus, Ohio
Osterberger, B. A., Baton Rouge, La.
Painter, R. H., Manhattan, Kans.
Parker, R. L., Manhattan, Kans.
Peairs, L. M., Morgantown, W. Va.
Peets, N. D., Brookhaven, Miss.
Pellett, F. C., Hamilton, Ill.
Pepper, J. O., Clemson College, S. C.
Pettit, R. H., E. Lansing, Mich.
Phillips, W. J., Charlottesville, Va.
Poe, S. E., Little Rock, Ark.
Polioka, J. B., Oak Harbor, Ohio
Poos, F. W., Norfolk, Va.
Porter, B. A., Washington, D. C.
Powers, E. B., Knoxville, Tenn.
Quaintance, A. L., Washington, D. C.
Regan, W. S., Yakima, Wash.
Reid, W. J., Chadbourn, N. C.
Richardson, C. H., Washington, D. C.
Riley, H. K., Lafayette, Ind.
Robinson, J. M., Auburn, Ala.
Rohwer, S. A., Washington, D. C.
Rude, C. S., Stillwater, Okla.
Ruffin, W. A., Auburn, Ala.
Ruggles, A. G., St. Paul, Minn.
Sanders, G. E., New York, N. Y.
Sanders, J. G., Philadelphia, Pa.
Sanders, P. D., College Park, Md.
Sasscer, E. R., Washington, D. C.
Satterthwait, A. F., Webster Groves, Mo.
Schenk, Gilbert, St. Louis, Mo.
Schoene, W. J., Blacksburg, Va.
Shelford, V. E., Champaign, Ill.
Smith, Charles E., Baton Rouge, La.
Smith, R. C., Manhattan, Kans.
Smith, M. R., A. & M. College, Miss.
Snapp, O. I., Fort Valley, Ga.
Spencer, Herbert, Baton Rouge, La.
Spooner, C. S., Charleston, Ill.
Stafford, E. W., A. & M. College, Miss.
Steiner, L. F., Wapakonata, Ohio
Stene, A. E., Kingston, R. I.
Stone, W. E., Sanford, Fla.
Strong, L. A., Sacramento, Calif.
Sullivan, K. C., Columbia, Mo.
Sweetman, H. L., St. Paul, Minn.
Thomas, F. L., College Station, Texas.
Tissot, A. N., Gainesville, Fla.
Turner, W. F., Macon, Ga.
Ulman, P. T., Auburn, Ind.
Underhill, G. W., Richmond, Va.
Van Dine, D. L., Central Baragua, Cuba.

Vickery, R. A., Stratford, Conn.
Wade, J. S., Washington, D. C.
Wallace, F. N., Indianapolis, Ind.
Walter, E. V., San Antonio, Texas
Wardle, R. A., St. Paul, Minn.
Weigel, C. A., Washington, D. C.
Wheeler, A. J., Madison, Tenn.
Wheeler, C. M., Knoxville, Tenn.
Whitmarsh, R. D., Deland, Fla.
Woodruff, L. C., Charlottesville, Va.
Worthley, H. N., State College, Pa.
Yeomans, M. S., Cornelia, Ga.

President R. W. Harned: I have the honor of calling to order the 40th annual meeting of the American Association of Economic Entomologists. (Applause)

The first business on the program is the report of the Secretary.

REPORT OF THE SECRETARY

The membership of the Association at the time of the Philadelphia meeting, together with the election of new members, resignations, those dropped for non-payment of dues and losses by death since is summarized as follows:

	Active	Associate	Foreign
Total Membership, beginning of Philadelphia meeting	392	407	50
Transferred from Associate to Active Membership, Philadelphia meeting	+35	—35	
	427	372	50
Members elected, Philadelphia meeting		+88	
Re-instatement, Philadelphia meeting		+ 1	
Resignations, Philadelphia meeting	—2	—3	
Total Membership, close of Philadelphia meeting	425	458	50
Dropped for non-payment of dues, 1927	—9	—22	
Deaths recorded since last meeting	—2		—3
Total Membership, beginning of Nashville meeting	414	436	47
Grand Total 897			
Net Gain 48			

R. I. Smith, Associate Plant Quarantine Officer of the Federal Horticultural Board, stationed at Boston, Mass., died of pleurisy and grippe, February 26, 1927, at the early age of 44. He had been an active member of the Association for a number of years, having worked in entomology for periods in Maryland, Georgia, North Carolina, Porto Rico and since 1915 in Boston.

Professor William Lochhead, Macdonald College, P. Q., Canada, an active member of this Association, died on March 26, 1927. He had been Professor of Biology and later Entomology and Zoology in Macdonald College since 1906 and was obliged to retire in 1925 on account of ill health.

Dr. Antonio Berlese, Director of the R. Stazione di Entomologia Agraria, Florence, Italy, a foreign member of this Association, died October 24, 1927. He had done a large amount of scientific work in entomology and had published many valuable papers.

At the last minute information was received of the death of Prof. Arthur E. Shipley, Cambridge, England and V. Vermorel, Rhone, France, foreign members. No details were given.

The 12th annual meeting of the Pacific Slope Branch was held June 22 and 23 at the University of Nevada, Reno. The meeting proved very interesting, although the attendance was not quite as high as at some previous meetings.

The Cotton States entomologists held its second meeting since becoming a branch of the Association, on February 2, 3 and 4, 1927, at Atlanta, Ga.

The second supplement to the common names of insects approved for general use by the American Association of Economic Entomologists was printed in the December number of the JOURNAL. 400 separates of this supplement were ordered to be offered for sale at 15 cents per copy.

500 separates of the original list and 500 of the first supplement were printed; the original list selling for 25 cents per copy and the first supplement at 15 cents.

JOURNAL OF ECONOMIC ENTOMOLOGY

The volume of the JOURNAL for the past few years contained: 520 pages in 1921; 446 pages in 1922; 568 pages in 1923; 693 pages in 1924; 872 pages in 1925; 895 pages in 1926 and 861 pages in 1927. The total pages in Volume 20, 1927, is about the same as that of the past two years. The JOURNAL for the first 16 years contained an average of 515 pages; for the last 4 years, an average of 830 pages, or an increase of 61%. In the last 7 years it has gained 66% in size or number of pages per volume without raising the subscription rates. The steady annual gain in membership adds materially to the subscription list. The management believes that the amount of entomological matter being published in the JOURNAL in total pages equals or exceeds in comparison that of any other scientific JOURNAL for the subscription price charged to members. Printing costs have remained about the same during the last few years but a total of more has been paid for printing due to the fact that larger issues have been put out each year.

Complete sets of the JOURNAL are still available excepting No. 2 of Vol. 1 which is out of print. Volumes 8, 11 and 18 have been selling for $4.00 and Volume 12 for $5.00. It has been necessary to advance the price of Volume 18 and 19 to $4.50 because of a shortage in some of the numbers. On foreign orders 50 cents extra is charged for postage. It may be necessary to increase the price of some of these volumes during next year.

The following table shows the total domestic and foreign subscribers in 1913, 1922, 1926 and 1927:

	1913	*1922*	*1926*	*1927*
Alabama	3	12	7	8
Arizona	7	6	14	18
Arkansas	2	6	5	7
California	34	63	112	118
Colorado	7	14	16	17
Connecticut	10	20	19	18
Delaware	3	3	6	6
Dist. of Columbia	50	53	60	61
Florida	7	20	27	27
Georgia	6	9	13	13
Idaho	2	4	8	7
Illinois	30	28	36	38
Indiana	16	13	15	18
Iowa	5	12	17	17

	1913	*1922*	*1926*	*1927*
Kansas	16	17	23	24
Kentucky	4	6	4	4
Louisiana	12	13	22	26
Maine	5	5	9	10
Maryland	11	10	11	12
Massachusetts	48	83	70	74
Michigan	15	12	15	19
Minnesota	10	14	15	14
Mississippi	4	25	32	34
Missouri	8	13	17	15
Montana	5	9	10	9
Nebraska	3	2	5	7
Nevada	1	2	3	3
New Hampshire	4	7	11	8
New Jersey	14	23	38	41
New Mexico	3	3	3	4
New York	52	61	89	85
North Carolina	6	9	14	14
North Dakota	0	1	1	1
Ohio	22	48	50	55
Oklahoma	2	4	7	7
Oregon	10	11	18	18
Pennsylvania	18	39	43	46
Rhode Island	3	4	5	4
South Carolina	4	6	13	11
South Dakota	1	2	2	2
Tennessee	6	11	12	14
Texas	16	23	32	39
Utah	8	13	10	12
Vermont	1	1	2	2
Virginia	7	15	18	18
Washington	8	12	12	12
West Virginia	5	5	6	7
Wisconsin	6	15	18	17
Wyoming	0	1	4	5
Total for U. S.	520	768	999	1046
U. S. Possessions	26			
Hawaii		11	11	11
Panama & Virgin Islands		2	3	2
Philippines		5	4	4
Porto Rico & Cuba		6	13	12
Canada	27	43	50	54
Foreign	132	163	257	285
GRAND TOTAL	705	998	1337	1414

It will be noted from the above table that a gain of 77 subscriptions has been made during 1927 compared with 98 in 1926 and 115 in 1925.

Index to the Literature of American Economic Entomology, I and II

The accounts of these two volumes have been combined since June 1925, at which time all the indebtedness to the Association had been made up. The sales of these numbers dropped slightly in 1927 over 1926 due to the fact that the demand is pretty well supplied at the present selling price per volume. There still remains on hand for sale about 475 copies of I and 500 copies of II.

From this combined account, $675 was loaned in 1925 for the publication of Index III, $200 of which was paid back in 1927, leaving $475 still due Index I and II. (See financial statement.)

Index to the Literature of American Economic Entomology, III

In the Secretary's report for 1925, it was stated that $1675 was borrowed from the Association, Journal and Index I and II accounts to assist in financing the publication of Index III. During 1926, $500 was re-paid and in 1927 $200 more was paid back, leaving a total indebtedness of $975, $475 of which is owed Index I and II and $500 to the Journal. (See financial statement.)

The sales of this Index dropped greatly in 1927, amounting to only $205.15 against $497.68 in 1926. There are still on hand for sale about 700 copies of this Index.

Recommendations

Due to the gradual decrease in the sales of Index I and II and the rather sharp decline of sales of Index III in 1927 and to the fact that we still have on hand about 475 copies of Index I,500 copies of Index II and 700 copies of Index III, it is recommended that the price per volume be reduced from $6.00 to $5.00 domestic and from $6.50 to $5.50 foreign.

Permanent Fund

At the Philadelphia meeting in 1926 the Association voted that the interest on all deposits be transferred annually to the credit of the Permanent Fund. In accordance with this vote, there was transferred to this account $316.50 interest in 1927. The Executive Committee also approved the transfer of $800 during 1927 from the Association account to this fund. Two life memberships, totaling $200, have been received during the year and have been credited to this fund. (See financial statement.)

Association Statement

Balance in Treasury, December 3, 1926		$1245.28
Amount received from dues and separates		1291.55
Amount received from bank interest		20.00
Paid—Stenographic Report, 1926	$ 207.70	
Postage	81.05	
Programs and Notices	42.05	
Supplies and Stationery	38.34	
Telegraph and Express	5.81	
Expenses, Pacific Slope & Cotton States Branch	22.31	
Transfer to Permanent Fund	800.00	
Secretary	100.00	
Clerical work, Secretary's Office	50.00	
Miscellaneous Expenses, Secretary's Office	21.70	
Mimeographing	21.15	

Transfer of Interest to Permanent Fund	$20.00	
Badges	20.00	
	$1430.11	
Balance, November 26, 1927	1126.72	
	$2556.83	$2556.83

Balance deposited in First National Bank, Malden, Mass.

JOURNAL STATEMENT

Balance in Treasury, December 3, 1926		$3140.67
Amount received from subscriptions, advertising, etc		5547.50
Amount received from bank interest		35.00
Paid—Postage	$ 259.64	
Printing	3604.50	
Programs and Notices	7.64	
Supplies and Stationery	35.62	
Half-tones and engravings	398.92	
Telegraph, Express and Freight	5.23	
Editor	200.00	
Clerical work, Editor's Office	105.00	
Business Manager	100.00	
Clerical work, Business Manager's Office	100.00	
Back numbers purchased	6.35	
Transfer of interest to Permanent Fund	35.00	
Collection charges	.65	
Miscellaneous Expenses, Business Mgrs. Office	5.90	
	$4864.45	
Balance, November 26, 1927	3858.72	
	$8723.17	$8723.17
Balance deposited in First National Bank, Malden, Mass		$2334.96
Balance deposited in Melrose Trust Company, Melrose, Mass (Including $1000 transferred from First National Bank, Malden, Mass., on December 23, 1926)		1523.76
		$3858.72

INDEX I AND II STATEMENT

Balance in Treasury, December 3, 1926		$ 346.31
Received from Sales		229.84
Interest on Deposit (17.63) exact		17.74
Received from Index III (Loan)		200.00
Paid—Postage	$ 8.30	
Transfer of interest to Permanent Fund	17.74	
	$ 26.04	
Balance, November 26, 1927	767.85	
	$ 793.89	$ 793.89

Balance deposited in First National Bank, Malden, Mass.

INDEX III STATEMENT

Balance in Treasury, December 3, 1926		$ 23.34
Received from Sales		205.15
Interest on Deposit		5.00
Paid—Postage	$ 7.11	
Transfer of Interest to Permanent Fund	5.00	
Payment on Loan from Index I and II	200.00	
	$ 212.11	
Balance, November 26, 1927	21.38	
	$ 233.49	$ 233.49

Balance deposited in First National Bank, Malden, Mass.

INDEBTEDNESS OF INDEX III

Index III owes Indices I and II	$ 475.00
Index III owes JOURNAL	500.00
Total indebtedness	$ 975.00

PERMANENT FUND

Deposit, Melrose Savings Bank, December 3, 1926	$2422.55
Interest on Deposits, Melrose Savings Bank	117.10
Interest on Liberty Bonds	70.12
1927 Interest from First National Bank, Malden (Accounts: Indices I, II, III, JOURNAL, Assoc.)	77.74
1927 Interest from Melrose Trust Company Savings Dept (JOURNAL account)	51.54
Paid into Permanent Fund from Association	800.00
Two Life Memberships	200.00
Deposited, Melrose Savings Bank, Melrose, Mass., November 26, 1927	$3739.05
4¼% Liberty Bonds	1600.00
GRAND TOTAL	$5339.05

SUMMARY

Balance in Indices I and II Account, November 26, 1927	$ 767.85
Balance in Index III Account, November 26, 1927	21.38
Balance in JOURNAL Account, November 26, 1927	3858.72
Balance in Association Account, November 26, 1927	1126.72
GRAND TOTAL	$5774.67

Respectfully submitted,
C. W. COLLINS, *Secretary*

Voted that the report be accepted and the recommendations regarding the reduction in price of $1.00 per volume of Indices I, II and III to the Literature of American Economic Entomology be referred to the Executive Committee with full power to act.

President R. W. Harned: The next is the report of the Executive Committee.

REPORT OF THE EXECUTIVE COMMITTEE

A resolution adopted last year in Philadelphia instructed your President to appoint a delegate to attend the meetings of the Cotton States Branch of this Association which held its second annual meeting in Atlanta, Georgia, on February 3 and 4, 1927. Dr. William Moore of New York was appointed to officially represent the parent Association. There was a good attendance at this meeting, including three members of the Executive Committee—the President, Third Vice-President Franklin Sherman, and Fourth Vice-President J. H. Montgomery.

Following the precedent set by the three previous administrations your President attended the 12th annual meeting of the Pacific Slope Branch held at Reno, Nevada, on June 22 and 23, 1927. Second Vice-President R. W. Doane presided at this meeting.

Both branches appear to be in a flourishing condition and are real assets to the Association. We suggest that members make a greater effort to attend the branch meetings outside of their own territory. The branches of the Association, as well as the visiting members who attend the meetings, will be benefited by this practice.

At the Kansas City meeting two years ago the Association decided to have a Committee on Program consisting of three members. President Gibson appointed for 1926 as members of this committee, A. F. Burgess (Chairman), W. E. Britton, and C. H. Hadley. At Philadelphia last year the Association voted to make the committee on Program one of the standing committees, but it was overlooked by the committee on Nominations. Your President reappointed the same committee for 1927. As Mr. Burgess urgently requested that he be relieved of the Chairmanship, Dr. Britton was appointed to that position. The committee for 1927 is therefore as follows: W. E. Britton (Chairman), A. F. Burgess, and C. H. Hadley.

The standing committee on Insect Pest Survey that was appointed in 1926 by President Gibson was also overlooked in Philadelphia last year. Your President reappointed the same committee to serve for 1927 except that instead of himself he appointed Dr. W. E. Hinds. The committee is therefore as follows: C. R. Crosby (Chairman), L. A. Strong, W. E. Hinds, R. A. Cooley, and J. M. Swaine.

The Advisory Committee on Research Work on the Control of the European Corn Borer was provided for in a resolution presented at the Kansas City meeting two years ago. The personnel of the committee is G. A. Dean (Chairman), D. J. Caffrey, J. J. Davis, C. J. Drake, and Lawson Caesar. A resolution adopted at Philadelphia last year made this one of our standing committees. As the Nominations Committee had not provided for the personnel of this committee, your President reappointed the same committee to serve for 1927.

A resolution adopted last year read as follows: "The special committee appointed by the President to investigate arsenical residues be made a standing committee." As this resolution apparently referred to the committee appointed by President Gibson, it was decided that no action was necessary during the present administration. This committee consists of A. L. Quaintance, G. A. Dean, P. J. Parrott, B. A. Porter, W. P. Flint, and Leroy Childs.

We recommend that in all cases of standing committees where the terms of office have not previously been designated, that the Nominations Committee be instructed to nominate one member, whose term will expire in one year, another to expire in two years, the third in three years, the fourth in four years, etc., with the exception of the committee on Nomenclature, which shall continue as previously planned.

Following instructions given in the report of the committee on Policy that was adopted last year, your President appointed as members of the committee to take charge of raising an Endowment for the Association, A. F. Burgess (Chairman), G. A. Dean, and J. G. Sanders. We recommend that this committee on Endowment be made a standing committee of the Association.

At the request of the Secretary the President secured the approval of all members of the Executive Committee for the transfer of the sum of $800 from the current fund of the Association to the Permanent Fund where it would draw a higher rate of interest.

Your President regrets that he failed to notice the recommendation of the last Executive Committee that he appoint two delegates to cooperate with the Organizing Committee in making necessary arrangements and carrying out the plans for the meeting of the First International Congress of Soil Science that was held in Washington, D. C., on June 13 to 22, 1927. In April the Secretary reported that he had received an invitation to attend this Congress and suggested that an official delegate be appointed. J. E. Graf was appointed as the official delegate from the Association to attend the First International Congress of Soil Science.

In June your President had the honor of appointing Dr. L. O. Howard and Dr. J. M. Swaine as delegates from this Association to attend the Tenth International Congress of Zoology at Budapest, Hungary, that was held in September.

Several months ago the Secretary mailed to each active member of the Association a copy of the change in our Constitution suggested by the Executive Committee last year. This change in the Constitution, if adopted, will add the Secretaries of the branches and sections to the Executive Committee. Upon the advice of the Secretary a committee was appointed to report at this meeting in regard to this proposed change in the Constitution. This committee is as follows: P. A. Glenn (Chairman), F. L. Thomas, and A. F. Burgess.

At Philadelphia last year Professor Essig made a motion that was adopted with reference to a card index on insecticides being referred to the Executive Committee to turn over either to the Editorial Board or the committee on Policy (See pages 45 and 46 of the JOURNAL OF EONCOMIC ENTOMOLOGY, February 1927). This matter was referred to the Editorial Board. Dr. Felt replied that "Although the Index of Insecticides may prove to be a somewhat complicated matter, the Editorial Board will accept your reference and see what can be done."

The Northeastern Entomologists, through a special committee consisting of T. J. Headlee (Chairman), E. N. Cory, P. J. Parrott, V. I. Safro, and A. F. Burgess, recently made application to this Association for authority to organize as a Branch of the American Association of Economic Entomologists to be known as the "Eastern Branch." This application is attached as a part of this report. It was also referred to the committee on Policy. The Executive Committee unanimously recommends that the application for the formation of the Eastern Branch be approved by the Association.

The Executive Committee has audited the books of the Secretary and found them to be correct, and proper endorsement has been made in the cash book.

Respectfully submitted:

R. W. HARNED
W. P. FLINT
R. W. DOANE
FRANKLIN SHERMAN
J. H. MONTGOMERY
F. E. MILLEN
C. W. COLLINS
Committee

APPLICATION OF THE NORTHEASTERN ENTOMOLOGISTS TO BECOME A BRANCH OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

To the American Association of Economic Entomologists:

At a session during the annual (1927) meeting of the Northeastern Entomologists held at Winchester, Va., on August 17th–19th, 1927, the undersigned committee was appointed with power "for the purpose of working out a form and method of procedure looking toward affiliation of the Northeastern Entomologists with the American Association as a branch."

Application to this effect is herewith made and the undersigned committee requests that this organization be known as the "Eastern Branch" of the American Association of Economic Entomologists with an organization similar to that prevailing in the present "Branches." The area will include the states of Virginia, West Virginia, and Pennsylvania, and all territory to the north and east thereof.

It is understood that the JOURNAL OF ECONOMIC ENTOMOLOGY, the official organ of the Association, shall publish each year the usual notices concerning the meeting and the usual resume of business transactions which will be duly furnished by the officers of the branch. It is agreed and understood that admission as a branch does not imply the publication in the JOURNAL to any greater extent than the prevailing policy and practice. Furthermore, it is understood that the officers of the branch shall, in their judgment, exercise the usual discretion as to number and length of papers for publication in the JOURNAL, and that this will be done with the cooperation and guidance of the editorial board of the JOURNAL.

The Northeastern Entomologists, herein suggested as "Eastern Branch," held its first annual meeting in Philadelphia on July 29th–30th, 1920. Since that time similar annual meetings have been held regularly within the territory covered by the states to be included in the "Eastern Branch." The organization was largely informal, without dues, meeting at that season of the year when summer trips would be most instructive. Thus far, no regular paper-reading sessions have been held, but more or less formal papers have been presented on specific subjects of general interest to the Eastern membership. At each annual meeting a special committee has been appointed, whose business it was to nominate a President and Secretary and to submit proposals for the place of the coming year's meeting. The time of the meeting during the following year was left for determination by the President and Secretary for that year.

The territory covered by the proposed branch includes a very large number of entomological workers, many of whom never have opportunity to attend a meeting of the National Association, except as the same is held in Boston, New York, Philadelphia, or Washington. Furthermore, there are many entomological workers in this territory who are not even members of the National Association, whom the formation of an "Eastern Branch" would induce to become members. In many ways the problems of the workers in the territory covered by the proposed "Eastern Branch" are similar. In addition, there exists within this territory such general problems as the Japanese beetle and gipsy moth. Also, there is a strong similarity to the problems incident to law enforcement throughout this territory.

It is believed that the formation of an "Eastern Branch" cannot fail to give strength to the parent Association and cannot fail to extend the Association's good influence to a large number of workers who, at present, are unable to take full advantage of it.

It is hoped that the American Association of Economic Entomologists will look favorably upon this request and extend authority for the formation of the "Eastern Branch."

E. N. Cory
P. J. Parrott
V. I. Safro
A. F. Burgess
T. J. Headlee, *Chairman*
Special Committee of Northeastern Entomologists

Voted that the report be accepted and the recommendations adopted.

President R. W. Harned: The next is the report of the Representative to the National Research Council.

NATIONAL RESEARCH COUNCIL REPORT ON THE WORK OF THE DIVISION OF BIOLOGY AND AGRICULTURE

The National Research Council, a cooperative organization for the promotion of scientific research, is founded on the principle of representation through the national scientific societies. Taking the Division of Biology and Agriculture as an example closest to our interests, fifteen societies in both the pure and the applied fields of biology are given opportunity (1) to select someone from their respective memberships to constitute, with several members-at-large chosen by the Division as a whole, the membership of the Division, (2) to bring to the Council the research needs in their own fields which this body may be in a position to encourage, and (3) to take an active part in the general work of the Division. The history of the Division has indicated that this plan for serving the scientific groups of the country has worked out unusually well. Already a dozen or so outstanding achievements have resulted and are now operating independently as major activities in the realm of science. The work of the Council, like its membership, is a continuing process and each year as certain projects branch out to stand alone more or less, new ones arise. Consequently there is at all times a large list of active projects. Those that may be of interest especially to the members of the American Association of Economic Entomologists are briefly reported upon below.

1. Forestry Committee.—The two principal projects of this Committee since early in 1920 have been: (1) quantitative and qualitative forest increment on cut-over lands and (2) standardization of silvicultural practise in the various forest regions of the United States. Support for these was furnished by the Southern Pine Association to the amount of $10,000 and during the several years of the conduct of the investigations additional support was received from State and Federal sources as follows: $500 from North Carolina, $1,000 from Louisiana, $1,000 from the U. S. Forest Service, some from Texas and support in other ways. This work was about completed in 1924 and publication of the results of the studies is to be consummated through the U. S. Department of Agriculture.

A smaller undertaking but one which proved of immediate value was the compilation in 1920 of a bulletin on North American Forest Research, published and made available to foresters by the National Research Council.

The Committee has concerned itself with a number of other equally important undertakings, among them the publication of a survey of the forest resources of the world. This was compiled under the Committee's direction and, with the assistance of the National Research Council, appeared in book form in 1923, publication being handled by the McGraw-Hill Book Company.

2. BIOLOGICAL ABSTRACTS.—Since the establishment of the Council, this Division in particular has been concerned especially in a study of publication needs, with a view to attempting to meet some of these. As a first step in this direction was the launching of International Biological Abstracts. This abstracting journal expects to cover the whole field of biological and closely related sciences.

3. COMMITTEE ON RESEARCH PUBLICATIONS.—The Division has further been concerned with a study of the needs among scientific biological journals for the publication of original research, with a view to attempting to devise means of meeting some of these. Dr. C. E. McClung has been chairman of this committee during the past few years but inasmuch as he is out of the country now for the full year and it is felt desirable to push this study this winter, the committee is being reorganized.

4. FELLOWSHIPS GROWING OUT OF ACTIVITY OF THE DIVISION.—In addition to a number of special fellowships, funds for which have been made available at various times for the support of particular pieces of research, there has been operating since 1923 a major series of fellowships known as the National Research Fellowships in the Biological Sciences and designed primarily for the training and development in fundamental biological science of individuals beyond the doctorate stage. These fellowships do not include within their scope agricultural research workers, except as they may be working along fundamental lines. The need for fellowships in agriculture is keenly appreciated and it is hoped that eventually support for some of this kind may be secured.

5. SULPHUR FELLOWSHIPS.—In 1922 the Texas Gulf Sulphur Company made available to the National Research Council a grant of $10,000 for the mainteanance of eight fellowships for the following investigations:

Use of sulphur for control of diseases of the sweet potato
Use of sulphur for control of soil insects
Control of nematodes by use of sulphur
Effect of sulphur on alkali soils
Use of sulphur as a fertilizer for alfalfa or other legumes
Use of sulphur in control of potato scab

An additional grant of $7,400 was received from the same source for fellowships during 1923–24. A small balance in the appropriation permitted of some short-time fellowships studies during 1925, 1926, and 1927.

6. BIOLOGICAL RELATIONS BETWEEN FLOWERS AND INSECTS.—This cooperative study developed from a suggestion which came out of a conference on biophysical problems held in Woods Hole in the summer of 1921. With F. E. Lutz (Chairman), J. Arthur Harris and F. K. Richtmyer as the committee appointed to take charge of these investigations, and with financial support from the American Museum of Natural History, Cornell University, the Station for Experimental Evolution at Cold Spring Harbor, the University of Colorado, the Tropical Research Station

of the New York Zoological Society, the Bausch and Lomb Optical Company, and the National Research Council, results were obtained which have been reported in the following papers:

Lutz, F. E. Apparently non-selective characters and combinations of characters, including a study of ultra-violet in relation to the flower-visiting habits of insects. Annals of the New York Academy of Science, 24:181–283, 1924.

Lutz, F. E. and Richtmyer, F. K. The reaction of Drosophila to ultra-violet. Science, N. S., 55:519, 1922.

Pope, Maxy. Pollen morphology as an index to plant relationship. Botanical Gazette, 80:63–73, 1925.

Richtmyer, F. K. The reflection of ultra-violet by flowers. Journal of the Optical Society of America, 7:151–68, 1923.

7. COMMITTEE ON TROPICAL RESEARCH.—This is a reorganization of what was formerly the Committee on Sub-tropical Biological Institution, which in turn was an outgrowth of other committees of the Division concerned with tropical biology and agriculture. It has been expedient to change the character and personnel of the Committee to accord with changes in the character and scope of the problems it has had previously before it for consideration. The project at present under advisement by the Committee is the establishment of a graduate school of tropical agriculture. On the basis of study of a number of possible sites and following visits by the Division Chairman of last year and the present Chairman, the Committee, with the endorsement of the Division, is recommending Porto Rico as the most suitable location for this proposed graduate school.

8. INSTITUTE FOR RESEARCH IN TROPICAL AMERICA.—The Institute for Research in Tropical America was organized, under the auspices of the Division of Biology and Agriculture, in January of 1921 for the purpose of promoting "research in Tropical America, by exploration, by the establishment of laboratories and research stations, by coordinating the efforts of cooperating institutions, and by such other methods as the Institute may adopt. While the work of the Institute may embrace scientific investigations of any nature relating to Tropical America, it will include primarily biological research in relation to the animals, the plants, the people, the geology and soils, and the climate, all with due reference to such aspects of applied biology as medicine, agriculture, forestry, and fisheries."

Since its organization the Institute has concentrated its energies largely upon the establishment of the Barro Colorado Island Biological Station in the Panama Canal Zone. The assistance of the National Research Council was sought in endorsing this project to the government of Panama to bring pressure to bear on securing the site desired for this Station. The Council gave its endorsement. The reserve was subsequently set aside, and with Dr. Thomas Barbour in charge plans for the establishment of the Station went forward without delay. It has been a going concern since the summer of 1923 and has received financial support from various sources. Some seventy-five persons, at least, have made use of the facilities at the laboratory during the few years of its operation.

9. TROPICAL PLANT RESEARCH FOUNDATION.—An organization developing out of one of the Division's committees and which is now independent of the National Research Council, except as the latter serves as its fiscal agent, is the Tropical Plant Research Foundation. During the several years since its establishment in 1924 the following research projects have been undertaken by the Foundation:

a. Investigation of Sugar Cane Production problems for the Cuba Sugar Club. Begun November 1, 1924, with an appropriation of $100,000 per annum for a five-year period.

b. Agricultural survey of the Gomez-Meña Plantation, Cuba, for the Warner Sugar Company. March to May, 1925. Completed at a cost of $3,309.76.

c. Forestry survey of Eastern Cuba, for the United Fruit Company and the Cuba Company. October, 1925 to September, 1926. Completed at a cost of $14,000. Supplemented by a special examination of the watershed area in the vicinity of Bañes, Cuba, for the United Fruit Company, November 17 to December 16, 1926. Completed at a cost of $962.16.

d. Survey of the sugar cane and cotton districts of western Peru, for the National Agrarian Society of Lima. January 1 to May 31, 1926. Completed at a cost of $6,000.

e. Library research on tropical woods, for the American Society of Mechanical Engineers. Begun August, 1926; not yet completed. Appropriaton, $915.00.

f. Tropical forest survey, supported by the Charles Lathrop Pack Forestry Trust. Begun March 10, 1927, with an appropriation of $19,500 for three years. (Field work to be started November 1, 1927.)

10. CROP PROTECTION INSTITUTE.—The work of this organization is no doubt well known by this time. Its establishment was effected in 1920, primarily "to promote the efficient control of injurious insects, diseases and toxic substances affecting economic and ornamental plants and their products as injurious to man, domestic animals and animal products; to support and direct research upon these and other problems of a similar nature; to extend cooperation between the scientific workers and the producers of chemicals, appliances, etc., and growers and packers and shippers, and to assist in the dissemination of scientifically correct information regarding the control of injurious insects, plant diseases and toxic substances."

Projects directed by the Institute may be concerned with:

a. The action or value of chemicals proposed for use in crop protection.

b. The value of fertilizers for the same purpose.

c. The perfecting of substances used for more successful growing of plants.

d. Determining the extent of damage done by a destructive insect or disease.

e. The treatment of mills or warehouses to eliminate damage due to insects.

f. The protection or treatment of food products, such as cereals or dried fruits.

g. Studies of by-products of manufacture to determine their possible use as insecticides or fungicides.

h. Studies of basic materials, such as copper or sulphur, to discover wider and better agricultural uses.

i. Inauguration of broad campaigns for suppression of outbreaks of destructive insects or plant diseases.

j. Establishing helpful relations between industrial organizations and scientific workers.

k. And other projects.

The first of the special projects under this plan was a study of sulphur and for a number of years a series of sulphur fellowships have been maintained by the Institute.

11. COMMITTEES ON COOPERATION.—In the initital stages of the Division's development, there was greater need than at present for utilizing every means of bringing to the national societies a better understanding of the *raison d'être* and

possible usefulness of the National Research Council, and to this end, in addition to the regular representation in the Division membership, committees on cooperation were suggested from the societies. For several years these committees functioned, and served the purpose for which they were established, but as the Council has become better known to the societies a number of them have been dropped by their respective societies. At present but five such committees are still existent, principally because of projects started by them and not yet consummated. It is interesting to note the evolution of these committees on cooperation from merely liaison bodies, as was at first conceived, into active working bodies.

On behalf of the Division of Biology and Agriculture, its present officers wish to call the attention of the members of the American Association of Economic Entomologists to the fact that the National Research Council is their organization and that the Division is the unit through which the Society secures its direct representation and to whom it may bring any matters in which the Council can be of assistance. The extent to which this Society along with the others included in this one unit, utilizes the Division organization as a means to accomplish some of its needs, is the extent to which the Division itself will justify its value to the societies.

W. A. RILEY

Voted that the report be adopted.

PRESIDENT R. W. HARNED: The Report of the Committee on Policy follows.

REPORT OF THE COMMITTEE ON POLICY

The personnel of the sub-committees for the year is as follows:

Publicity—Messrs. Burgess, Collins, and Felt.
Insecticides and Appliances—Messrs. Haseman, Felt and Ruggles.
Regulatory and Control—Messrs. Ruggles, Gibson and Burgess.
Technical Training and Research—Messrs. Riley, Swaine and Harned.

The application from the special committee of Northeastern Entomologists, to the Association, regarding the creation of an additional branch to be known as the "Eastern Branch" is approved by the Committee on Policy.

The Committee desires to record its appreciation of the development of the Insect Pest Surveys in the United States and Canada. The data, thus presented is, we feel, appreciated by economic workers generally.

The Committee also notes, with considerable interest, the very close co-operation which has recently been established between the entomologist, the agronomist, the animal husbandman, and other scientists particularly in research connected with the control of the European corn borer. Many problems of the future will undoubtedly be solved more quickly with similar close co-operation.

The sub-committee on Insecticides and Appliances reports as follows:

"Never before in the history of Economic Entomology has the subject of insecticides and appliances received so much attention as at the present time. With the increasing problems presented by such scourges as the European corn borer, the Japanese beetle and the codling moth and spray residue, new and improved machinery and new and improved insecticides are indispensable. In their efforts to further the cause of Economic Entomology those entomologists, chemists, engineers and manufacturers devoting special attention to the improving of insecticides and insecticide machinery should receive every encouragement and assistance possible. On the other hand the tendency on the part of some firms to rush upon the market with new and untested insecticides or machinery should be discouraged.

The following summary indicates the lines of investigation receiving special attention during the year:—

Oils. From the data received it is evident that oils and oil emulsions and particularly white oils for foliage sprays have received more attention than any other type of insecticide. During the year special attention has been paid to the use of oil emulsions as ovicides in codling moth investigations and the results have been contradictory. Further investigations of the various oil emulsions for the control of San Jose scale have also been reported.

Substitutes for Nicotine. Next to oils, substitutes for nicotine have been reported as receiving most attention. Various new spray mixtures containing extracts of pyrethrum and derris have been tested as substitutes for nicotine and the results secured have been favorable in most cases. Pyrethrum soap has also received special attention. Compounds related to nicotine in the pyridine and pyrrolidine series have also been investigated.

Toxicity Investigations. During the year a great many workers have reported progress on toxicity investigations. The chemicals tested include both stomach poisons and contact insecticides. In the group of stomach poisons the fluosilicates, water soluble dyes, and arsenicals have received special attention. In the group of contact chemicals, nicotine and related compounds, derris, pyrethrum and compounds of high toxicity in the pyridine and dipyridyl series have been investigated.

Arsenicals. Special attention has been given to the question of spray residue on apples where arsenical sprays are used for the control of the codling moth.

Dusting. A growing interest is shown in the investigation of dust applications as supplements to spray applications on apple orchards and as substitutes for the regular sprays. Here again results reported are contradictory.

Machinery for Corn Borer Control. Few reports were received touching on the investigation of appliances. The outstanding new developments in the way of appliances for the control of insects during the year have been with machinery used in the control of the European corn borer.

Airplane Dusting. The use of the airplane for the application of insecticides to forest and fruit trees and to field crops, notably cotton, has been previously reported and no new lines of progress were reported for the present year.

At the time of the Philadelphia meeting of this Association, your Committee on Policy asked authorization to secure the opinion of the membership relative to the following questions:

1. "What, in your opinion, is the value of training in botany, chemistry, general zoology, and general physiology in the technical preparation for research in economic entomology?"

2. "From the standpoint of advancement in methods of insect control, what benefits would likely accrue from the establishment of a great entomological research organization devoting its energies to purely fundamental investigations in such fields as parasitism, insect physiology, insect ecology, and toxicology of inorganic and organic compounds?"

3. "In your judgment, which is the better policy, to foster a central research organization or to use the influence of the Association in encouraging members of the staffs of the higher institutions of learning who are capable of conducting productive research along the desired lines?"

These questions were referred to a sub-committee of the Committee on Policy. The method of sending out a questionnaire to the membership of the Association was carefully considered and it was the unanimous opinion that the data which might be so received would not justify the imposing of one of these types of inquisition. On the other hand, attempt has been made to obtain representative opinion through correspondence and through personal conference, and as a result the following suggestions are submitted:

Regarding fundamental preparation for research in Economic Entomology there is such unanimity of opinion in our membership that it might seem superfluous to refer to the need again. Unfortunately students are still leaving our various institutions, both graduate and undergraduate, with narrow training and with a narrow conception of their chosen field of work. A common complaint is that they are still allowed to specialize at an early date in some supposedly limited field of entomology to the neglect of supporting subjects. Too often they have stressed some current fad in biological work to the exclusion of the breadth of training which we all agree is essential. These dangers demand repeated emphasis, not only for students but for teachers advising them.

While training in supporting sciences is freely admitted to be essential, it seems desirable to stress at this point the necessity that the student of promise get his training in foreign languages during his undergraduate days. Too often he comes to the crowded period of graduate study, eager to devote himself to his chosen problem, only to find that he must spend a large share of his time and energy in obtaining this preparation which is essential to sound work. All too often he is inclined to regard the requirement as a formal one, to be met and forgotten. The remedy for this situation lies logically in the hands of undergraduate advisers.

The second question raised, that of the desirability of establishing a central entomological research organization, is one which is not so easily answered but which demands a thorough study: insofar as the various viewpoints obtained may be harmonized, your sub-committee believes the following statements justified:—

1. Advantage should be taken of every opportunity to stimulate fundamental research in the field of entomology through the co-operation of existing organizations and through the creation of new agencies.

2. The new agency which would yield the greatest return on the investment would be one which, like the Crop Protection Institute, expended its funds in encouraging research in the higher institutions of learning. This opinion is based on the facts that:—

(1) The prime function of a university is to foster research.

(2) It possesses the staff, equipment, and the library facilities to varying extent, but capable of expansion at relatively little expense. Its atmosphere is one of co-operation and of willingness to sacrifice for the sake of research when there is competent leadership.

(3) To it there is a steady stream of new recruits ready and anxious to join forces with the investigator of ability,—not as technicians, but as zealous companions in research.

(4) In the university are already developed the methods of administration capable of adaptation to the needs of such work and there is to a marked degree, freedom from the red-tape which hampers the investigator.

(5) The enormous overhead expense of maintaining and administering the work would be reduced to a minimum and thereby a maximum return on the money expended would be secured.

(6) Instead of depleting of staff and a general weakening of agencies already established, to the end of building up one central institution, there would be a number of research centers distributed over the country and given the support which is now lacking to develop their resources, and to gather together, relieve from routine, and hold the man equipped to carry on research of the highest order and to stimulate others in this respect.

The sub-committees on Publicity and Regulatory and Control have no matters to bring to the attention of the Association at this time.

All of which is respectfully submitted.

ARTHUR GIBSON, *Chairman*
A. F. BURGESS
E. P. FELT
C. W. COLLINS
R. W. HARNED
W. A. RILEY
A. G. RUGGLES
L. HASEMAN
J. M. SWAINE
Committee

Voted that the report be adopted.

PRESIDENT R. W. HARNED: We will now listen to the report of the Trustees of the Crop Protection Institute.

REPORT OF THE CROP PROTECTION INSTITUTE FOR 1927

At the close of 1927 the Crop Protection Institute has fifteen research projects under way. These include the following, with headquarters at the places indicated:

Control of crown gall, with certain phases in progress in Madison, Wisc., others at Ames, Iowa, and still others at the Boyce Thompson Institute, at Yonkers, N. Y. Practical solution of certain aspects of this perplexing problem is now assured.

Plant diseases carried by seeds. An exhaustive study of factors favoring and inhibiting seed-borne parasites. At the Boyce Thompson Institute, at Yonkers, N. Y.

Thallium and mercury compounds as insecticides and rodenticides. At the Boyce Thompson Institute, at Yonkers, N. Y.

Insecticidal possibilities of the white oil emulsion known as "Volck." At the Kansas Experiment Station, at Manhattan.

Fungicidal action of a new colloidal sulphur. Headquarters at the Illinois Experiment Station, at Urbana, with additional work at Madison, Wisc.

New colloidal copper compounds. At the Boyce Thompson Institute, at Yonkers, N. Y., with supplementary work in various states.

New compounds derived from furfural and furfuramid. Major aspects at the Iowa State Experiment Station, at Ames. with additional studies at the Colorado Experiment Station, at Fort Collins.

Oil compounds as cattle sprays. At Lafayette, Ind.

Insecticidal development of the household spray "Kip." At Lafayette, Ind.

Development of new oil emulsions. At the Illinois Experiment Station, Urbana.

Development of the household spray known as "Flit." At the New Jersey Experiment station, at New Brunswick.

New Horticultural Sprays, a new project started in December 1927. At the Connecticut Experiment Station, at New Haven.

The physical character of atomized sprays. At the New Jersey Experiment Station, at New Brunswick.

Oxidized oils as insecticides, a new project started in December 1927. At the Lake Alfred Sub-station, at Lake Alfred, Fla.

Organic Insecticides. At the New Jersey Experiment Station, at New Brunswick.

At the close of 1927 the Institute has fifteen research workers on its staff. With two exceptions these are full-time men who are devoting their entire energies to organized programs of research, much of it of a fundamental character. As the work has developed it has steadily taken the form of more and more extensive projects requiring men of the best possible training and frequently men of considerable experience. The compensation available has steadily advanced, accordingly. The Institute is now paying some of its men at the rate of $3,000 to $3600 a year.

Opportunity for completing requirements for the doctorate degree continues to be afforded in certain cases. It usually happens that some part of the work that a man is doing lends itself very well to the needs of a doctor's dissertation. It has been found possible occasionally to permit a member of the staff to take one subject at a time in university work.

The outstanding feature of the Institute's activities continues to be the correlation of expert knowledge possessed by various large industrial organizations, some of which are already maintaining extensive research departments, with the biological knowledge possessed by the research worker and the committee in charge of a project, both of these made effective through the facilities placed at the disposal of the Institute by experiment stations, university laboratories, and such research foundations as the Boyce Thompson Institute.

W. C. O'Kane
P. J. Parrott
W. P. Flint
Committee

Voted that the report be accepted.

President R. W. Harned: Next is the report of the Scientific Trustee, Tropical Plant Research Foundation.

REPORT OF SCIENTIFIC TRUSTEE, TROPICAL PLANT RESEARCH FOUNDATION

I have no very important additions to report in entomological phases of the Foundation's work. The general work of the Foundation has been progressing well and a number of projects under way are being advanced as rapidly as could be expected. The Foundation has a very well equipped laboratory at Central Baragua and is working there particularly on insects connected with dissemination of cane mosaic and with cane mealy bug and cane borer. The latter species is being studied also at Central Jaronu, where conditions in parasitism have been quite different than at Jaronu. Aside from Capt. Van Dine, Mr. Stahl and Mr. Plank are engaged in entomological problems. A visit to the Canal Zone in May with opportunity to inspect the Bairo Colorado Laboratory while not directly related to the Foundation gave me an opportunity to learn something of the research opportunities in the tropics and to appreciate the advantage and desirability of well equipped research laboratories for entomological work. There are of course opportunities for indefinite expansion in entomological work.

I may mention also that frequent reports on the financial conditions of the Foundation show a close supervision of expenditures and details may be learned on application.

Respectfully submitted,
HERBERT OSBORN
Scientific Trustee

Voted that the report be accepted.

PRESIDENT R. W. HARNED: The next is the report of the Representatives on the Council of the Union of American Biological Societies.

REPORT OF REPRESENTATIVES OF THE COUNCIL OF THE UNION OF AMERICAN BIOLOGICAL SOCIETIES

There have not been, apparently, during the year, developments in the Union of American Biological Societies of sufficient importance to require the holding of a meeting of the members of the council in connection with the Association meetings in Nashville. This condition of affairs must be regarded as very favorable and indicates a smoothly running organization.

Dr. J. R. Schramm, Editor and Chief of Biological Abstracts, has furnished to members of the council, under date of December 18, 1927, a report on Biological Abstracts for the information of the member Societies of the Union. This report, comprising some three or four pages, goes into detail as to the present status of Biological Abstracts, and we anticipate will be published. It appears this work is being done very thoroughly and progress is being made as rapidly as advisable.

The adequacy of Biological Abstracts to meet the bibliographic requirements of economic entomologists, it will be recalled, was under discussion at the Association's last meeting at Philadelphia. Doctor Felt may present this question to the Association for possible further consideration at the present session.

A. L. QUAINTANCE
C. R. CROSBY
Representatives

Voted that the report be accepted and placed on file.

President R. W. Harned: Next we will listen to the report of the Committee on Nomenclature.

REPORT OF THE COMMITTEE ON NOMENCLATURE

The Committee begs to report that during the past year it has published the second supplement to the list of approved common names in the Journal of Economic Entomology, Vol. 20, No. 6, December, 1927. Forty-two names appeared in this list, two of which through an oversight, in checking, had already been approved in the same form. Two mistakes appear in this list in the matter of the word "botfly;" nose bot fly should have read nose botfly and sheep bot fly, sheep botfly.

In conformity with the policy announced in the last report of this Committee no extensive list of common names is to be presented at this time. A few questions of decided importance, however, have come to the attention of the Committee during the past year, and are presented herewith. The following common names have been suggested:

Laspeyresia molesta Busck	Oriental fruit moth
Psallus seriatus Reut	Cotton flea hopper
Laspeyresia caryana Fitch	Pecan shuck worm and Hickory shuck worm
Coleophora caryaefoliella Clem	Pecan cigar case-bearer and Hickory case-bearer
Sesia scitula Harr	Pecan sesia
Acrobasis hebescella Hulst	Pecan nut case-bearer and Hickory nut worm
Listronotus obliquus Gyll	Vegetable weevil
Trioza diospyri Ashmead	Persimmon psylla

In the case of *Psallus seriatus*, the name should be decided by the cotton states' branch, as the insect is principally a cotton pest. This body, I understand, has deliberated and failed to come to any conclusion as to the correct name to be applied to this insect.

The International Great Plains Crop Pest Committee has presented to the American Association through its Committe on Common Names the following resolution:

Resolution re. common name of *Cephus cinctus* Nort.

Whereas, no common name has been officially recognized by the American Association of Economic Entomologists for *Cephus cinctus* Nort., the name western cephid, which was submitted by the Committee on Common Names of that Association, having been rejected by the Association as a whole; and

Whereas, this species is of such great economic importance as to justify and make requisite the official adoption of a common name for it; and

Whereas, the name wheat-stem sawfly has been used for this species by entomologists, farmers, and the general public and for all recent publications, posters, newspaper articles and open meetings throughout the territory where this insect is of economic importance, with the result that this name is, in fact, the accepted common name for *Cephus cinctus* Nort.; therefore, be it

Resolved, by the International Great Plains Crop Pest Committee in session at Saskatoon, Saskatchewan, September 1, 1927, representing the official entomologists directly concerned with this insect, that the American Association of Economic Entomologists be requested and urged officially to adopt the name wheat-stem sawfly as the common name for *Cephus cinctus* Nort., and that a copy of this resolution be forwarded by the Chairman to the Secretary of the Committee on Common Names of that Association.

Minnesota:
  Robert A. Wardle, University of Minnesota.

North Dakota:
  J. A. Munro, Experiment Station, Farge.

Montana:
  Stewart Lockwood, U. S. Entomological Laboratory.
  W. B. Mabee, Experiment Station, Bozeman.
  N. C. Phillips, State College of Agriculture, Bozeman.

Alberta:
  E. H. Strickland, University of Alberta.
  H. L. Seamans, in charge, Dominion Entomological Laboratory.
  H. E. Gray, Dominion Entomological Laboratory.

Saskatchewan:
  S. H. Vigor. Saskatchewan Department of Agriculture.
  Eric Hearle, Dominion Entomological Laboratory, Indian Head.
  K. E. Stewart, Dominion Entomological Laboratory, Indian Head.
  K. M. King, in charge Dominion Entomological Laboratory, Saskatoon.
  N. J. Atkinson, Dominion Entomological Laboratory, Saskatoon.
  Ellis McMillan, Dominion Entomological Laboratory, Saskatoon.

Manitoba:
  A. V. Mitchener, Manitoba Agricultural College.
  Norman Criddle, in charge, Dominion Entomological Laboratory.

Ontario:
  H. G. Crawford, Dominion Entomological Branch.

NORMAN CRIDDLE, *Chairman.*
KENNETH M. KING, *Secretary.*

In order to facilitate the carrying out of the program of this meeting, the Committee begs leave to follow the procedure of previous years and submit these names in typewritten form to the members of the Association for their approval, with permission to publish as approved all names to which no more than 5 objections are received on or before April 1, 1928.

E. O. ESSIG, *Chairman*
F. C. BISHOPP
H. B. HUNGERFORD
H. G. CRAWFORD
J. A. HYSLOP
Committee

Voted that the report be accepted.

President R. W. Harned: The next item of business is the report of the Committee on Endowment.

REPORT OF COMMITTEE ON ENDOWMENT

The Committee on Endowment appointed by President Harned has begun work. Requests were sent to one member in each State to act as chairman for the purpose of organizing the members in his district in this project. Twenty members have consented to represent States and Provinces in Canada, and responses from others are being received.

As might be expected rapid progress on this project is not possible. Few members can accomplish very much without a real sacrifice of time and effort. Furthermore the urgent arguments that could be used to secure large donations such as would be possible in the case of a nation wide or even local catastrophe are entirely missing. This means that support must be secured from those who appreciate or have some gratitude for the work which the economic entomologist has done in America and the important results secured by his efforts. An appeal of this nature will naturally have increased weight if it can be shown that the membership has contributed materially to the project.

The amount of the endowment fund during the past year has increased from $4,022.55 to $5,339.05. This has been due to transfers from the general fund and to receipts from two full life memberships.

The committee has endeavored to arouse interest among the members in taking life membership which can be paid in full or spread over a period of five years. A more general response would be most helpful in furthering the work on this subject.

An attempt will be made to keep the entire membership informed of the progress of this work by publication of information in each issue of the Journal of Economic Entomology.

The committee will be grateful for suggestions or aid from any or all of the members.

Respectfully submitted,
A. F. Burgess *Chairman*
J. G. Sanders
G. A. Dean
Committee

Voted that the report be accepted.

President R. W. Harned: The report of the Editorial Board on Index of Economic Entomology is next in order.

REPORT OF THE COMMITTEE ON THE INDEX OF ECONOMIC ENTOMOLOGY, BIOLOGICAL ABSTRACTS AND THE INDEX OF INSECTICIDES AND FUNGICIDES

The situation in regard to the Index of American Entomology was outlined in the preceding report. Shortly after the report was submitted, the Committee received information to the effect that conditions were then favorable for the compilation of another Index, provided it was started shortly, whereas if this were not done, it might be impossible to secure a continuation of the work. Under the conditions, no definite action having been taken by the Association, the Committee decided it advisable to have compilation started upon the Index, leaving the matter of publication for solution later. This decision was communicated to Dr. Howard, then Chief of the Bureau of Entomology, and he gave instructions to have the compilation continued.

Biological Abstracts has operated so smoothly that there has been no call for the services of the Committee in relation thereto.

The advisability of preparing an index and abstract of all literature relative to insecticides was brought up at the last meeting by Prof. E. O. Essig. It was referred to the Executive Committee and by that group through President Harned to the undersigned. It came to our knowledge that a comprehensive work of this general character was contemplated in the federal Bureau of Entomology, and after some correspondence with Dr. A. L. Quaintance of that Bureau and other interested parties, a comprehensive, tentative outline for a Pharmacopoeia of Insecticides and Fungicides was submitted for the information of the Committee, and has just recently received official approval. It provides for a comprehensive compilation by the Bureaus of Chemistry and Soils, Plant Industry and Entomology working in cooperation. It is hoped that one person from each of the three Bureaus can be assigned full time, or nearly so, to the work with the expectation, that it will be issued as a department publication. Those in charge of the work will welcome suggestions and direct assistance from any and all pathologists, entomologists, chemists and others, who may be able to aid in this undertaking. The Committee in Charge consists of the following: Dr. E. L. Griffin, Dr. R. C. Roark, Bureau of Chemistry; Mr. W. W. Gilbert, Dr. J. W. Roberts, Bureau of Plant Industry; Mr. W. S. Abbott, Dr. C. H. Richardson, Bureau of Entomology.

It is planned to make each important product or group of products the basis of a single publication. The order in which these are taken up is to be left to the committee in charge.

Insecticides and fungicides play a most important part in the protection of plants from insects and fungous diseases and those cognizant of the situation cannot fail to recognize the great desirability of a comprehensive summation, such as outlined above. Your committee suggests that mimeographed copies of the general plan be widely distributed among working entomologists, not only in this country but abroad, accompanied by a personal invitation to assist in forwarding the project.

Respectfully submitted,

E. P. Felt
W. E. Britton
C. W. Collins
Committee

Voted that the report be accepted.

President R. W. Harned: We will now listen to the report of the Board of Trustees for the Permanent Fund.

REPORT OF BOARD OF TRUSTEES FOR THE PERMANENT FUND

At the Philadelphia meeting in 1926, the Committee on Policy recommended, and the Association voted, "to create a Board of Trustees for the Permanent Fund which shall have charge of all moneys placed in this fund and shall be responsible for their proper investment."

Provision was first made for a permanent fund at the Toronto meeting in December, 1921 and it has grown from $1334.75 to $5339.05 at the end of 1927, as follows:

Deposit, Melrose Savings Bank, Dec. 3, 1926	$2422.55
Interest Credited in 1927	316.50
Transferred from Association, 1927	800.00
Life membership fees received, 1927	200.00
	$3739.05
Investment in 4¼% Liberty Bonds	1600.00
GRAND TOTAL	$5339.05

This fund has grown from its beginning, as follows:

1922	$1334.75
1923	1893.33
1924	2373.08
1925	3389.01
1926	4022.55
1927	5339.05

Respectfully submitted,

R. W. HARNED
G. M. BENTLEY
E. N. CORY
T. J. HEADLEE
C. W. COLLINS, *Chairman*

Voted that the report be accepted.

PRESIDENT R. W. HARNED: The next is the report of the Committee on U. S. National Museum.

REPORT OF COMMITTEE ON U. S. NATIONAL MUSEUM

The Report of its Committee on U. S. National Museum, as presented to the Entomological Society of America, deals in detail with the Collections added during the past year. In this Report, therefore, we shall not touch that important phase of the subject but we shall refer primarily to the even more critical problems of personnel, working quarters and general facilities for securing more adequate use of these collections and for making the taxonomic work, which is so important to the Economic Entomologist, of greatest service to the Science of Entomology.

FIRST: We recognize the fundamental importance of developing the most complete collections of all forms of Insects where they may be available for study by specialists.

SECOND: Given the collections which are already extensive and are increasing so rapidly that it is even now impossible with the men, funds and quarters available to handle these collections in a satisfactory manner, we believe that the American Association of Economic Entomologists should consider the needs of this work and should do everything possible to secure the provision for meeting those needs. A brief review of some facts may help many of our members to understand this situation.

The Entomological Work in the National Museum is carried on through co-operative efforts of the Museum and of the Bureau of Entomology. The Museum provides the quarters which are now entirely inadequate, and pays three full-time employees: Dr. J. M. Aldrich and two sub-professional helpers. The Museum authorities are also now paying Mr. Buchanan for his work on the Casey Collection which is being labelled and transferred from the original containers to the standard type of Museum equipment. All other workers in the Museum entomological collections are employed by the Bureau of Entomology. This includes such extremely valuable men as Caudell, Busck, Gahan, Schaus and others. We understand that the Museum Budget does not provide for any definite increase in this work. The Bureau of Entomology Budget for 1929 as recommended to Congress provides for this work a total of $130,000 for "Taxonomy and Interrelations of Insects." Of this amount it is expected that $90,000 will be allotted to taxonomic work.

To state the additional needs for personnel as specifically as we can at the present time, it seems that the following competent specialists should be added: Two Hymenopterists, 2 Coleopterists, 1 Lepidopterist, 1 Hemipterist. To these specialists should be added at least three sub-professionl assistants to aid in preparation of material and of illustrations, indexing literature, etc. Also there is need for at least three more sub-professional students to aid in preparing material for study and in incorporating it in the collection.

If such increase in personnel can be provided, it will make possible far more complete and prompt utilization of, and reports on, materials already available, and as it is submitted.

THIRD: There is urgent need for enlarged quarters for properly storing and handling these valuable collections. This can be provided only through new building plans. Some provision for this is included in the plans which have already been approved by Congress.

FOURTH: We recommend that the members of this Association, and all interested in the progress of Entomology, utilize every opportunity to impress directly upon their representatives in Congress their views as to the national importance of this work so that Congress may act intelligently and favorably in providing for meeting these needs in our National Museum work in Entomology.

W. E. HINDS
R. W. HARNED
J. J. DAVIS
Committee

MR. ARTHUR GIBSON: I am wondering if the duties of this Committee could not be enlarged to include the Canadian National Collection. We in Canada are getting up a collection which we hope at sometime will be comparable to that maintained at Washington. As the Association is composed of United States and Canadian entomologists, I am wondering if some provision cannot be made in the duties of this committee to make reference to our collection in Canada. I am throwing that out as a suggestion.

MR. A. F. BURGESS: I move that the scope of this committee be extended so that consideration be given to the national collection of Canada.

The amendment was agreed to.

Voted that the report, as amended, be accepted.

President R. W. Harned: The next item of business is the report of the Program Committee.

REPORT OF COMMITTEE ON PROGRAM

In arranging the program for this meeting your committee has considered the suggestions made and the discussion occurring at the Philadelphia meeting. Consequently the time limit on papers for the general program has been reduced to five minutes, except in the Symposia, where men invited to present papers have been allowed ten minutes.

The suggestion that the entire program be arranged as a series of symposia has not seemed to meet with general favor. Your committee feels that such a plan may eliminate many papers of merit which do not happen to be closely related to the subjects treated in the symposia.

The paper of Roger C. Smith printed in the October issue of the Journal contains constructive plans for future meetings. Your committee invited comment and discussion, but only one letter has been received; it suggests that, instead of reading all committee reports at meetings and occupying much valuable time, such of these reports as require no action by the Association be printed in the December issue of the Journal. Members could then read the reports and bring them up for discussion at the meeting, if desired.

Your committee is unanimously of the opinion that no radical changes should be made in the conduct of our meetings without first having such changes sanctioned by a vote of the Association.

Respectfully submitted,
W. E. Britton
A. F. Burgess
C. H. Hadley
Committee on Program

Voted that the report be accepted.

President R. W. Harned: Next is the report of the Committee to Formulate Plans for the Investigation of the Codling Moth from Biologic and Control Standpoints.

REPORT OF COMMITTEE TO FORMULATE PLANS FOR INVESTIGATIONS OF THE CODLING MOTH FROM BIOLOGIC AND CONTROL STANDPOINTS

This committee started to function the week following its appointment at Philadelphia, by meeting at Washington. A number of other entomologists interested in the codling moth problem sat with the Committee, and all phases of the problem were discussed at length. As a result of this meeting a comprehensive outline was prepared and sent out to entomologists who might be contemplating codling moth work during 1927. From this outline the different collaborators selected phases of the problem which could be advantageously studied under their respective conditions. While it was recognized that complete uniformity of procedure and methods was not practicable and might be even undesirable, an effort has been made to correlate the work carried on by different agencies. The Committee feels that a good start has been made in this direction.

To enable the Committee to present a satisfactory summary of the results obtained this season, an inquiry was addressed to nearly forty entomologists. A generous and almost unanimous response to this inquiry has made it possible to present a fairly complete summary of the status of the codling moth problem.

Replies were received from the following cooperators. They are listed under the states in which the work was done, and the nature of the information supplied is indicated:

ARKANSAS. A. J. Ackerman, U. S. Bureau of Entomology.

Data on field tests of six non-lead arsenicals, of oil sprays used with and without lead arsenate, of nicotine sulphate, and of dusts for late applications; spray residue analyses of material from a number of plats.

CALIFORNIA. W. B. Herms and Arthur D. Borden, University of California.

Spray residue situation, oil spray tests, banding materials, bait traps, and seasonal life history notes.

GEORGIA. C. H. Alden, Georgia State Board of Entomology.

Spray residue situation; field tests of six possible substitutes for arsenate of lead; dusts,—full schedule and late applications; oil sprays; residue removal by brushing machinery; bands, ordinary and self-working.

ILLINOIS. W. P. Flint and associates, Illinois State Natural History Survey.

Spray residue situation with numerous analyses; field tests of calcium and magnesium arsenates, of dusts throughout season and in late applications, and of oil sprays; banding; behavior of larvae in search of hibernating quarters. Also tests on truck crop insects of many possible substitutes for arsenate of lead.

INDIANA. J. J. Davis and L. F. Steiner, Purdue University.

Bait and light traps, treated and untreated bands, detailed observations on orchard and packing shed sanitation, repellants in spray materials, non-arsenical sprays, relative value of first brood sprays, larval and adult behavior studies, hibernation studies, parasites, and residue analyses.

C. L. Burkholder, Purdue University.

History of clean-up program followed in certain orchards; experiments with home-made equipment for removal of residue with dilute hydrochloric acid.

B. A. Porter and R. F. Sazama, U. S. Bureau of Entomology.

Laboratory tests and foliage injury tests with a number of possible substitutes for arsenate of lead; field tests with eleven possible substitutes; spray residue analyses.

KANSAS. P. M. Gilmer and Howard Baker, U. S. Bureau of Entomology.

Field tests of eight possible substitutes for arsenate of lead, of variations in dosage of arsenate of lead, of oil sprays with and without arsenate of lead; bands, self-working and ordinary; spray residue analyses.

KENTUCKY. A. J. Olney and H. H. Jewett, University of Kentucky.

Field tests of lead at two dosages, of oil with and without lead, of a spreader, omission and doubling of calyx spray; residue analyses.

MARYLAND. N. E. McIndoo, Bureau of Entomology.

Observations on habits of newly hatched and mature larvae.

E. H. Siegler and associates, Bureau of Entomology.

Chemically treated bands.

MISSOURI. L. Haseman, Missouri Agricultural Experiment Station.

Residue situation, field tests with dusts, seasonal records, and observations on orchard sanitation.

MICHIGAN. R. H. Pettit, Michigan Agricultural College.

Field tests against grape berry moth with six possible substitutes for arsenate of lead. Residue analyses.

L. G. Gentner, Michigan Agricultural College.

Foliage injury tests with six possible substitutes for arsenate of lead; field tests with oil sprays and nicotine sulphate against codling moth.

NEW HAMPSHIRE. W. C. O'Kane, University of New Hampshire.

Comparative results from reduction in the number of applications, reduced dosage, substitution of calcium arsenate for lead arsenate, substitution of dust for spray, and substitution of oils for mineral poisons, also determination of residue.

NEW MEXICO. Fabian Garcia, New Mexico Agricultural Experiment Station.

Spray residue analyses.

NEW JERSEY. E. R. Van Leeuwen and associates, Bureau of Entomology.

Laboratory tests with some 260 possible substitutes for arsente of lead; behavior of newly hatched and mature larvae; injury tests of eleven possible substitutes for arsenate of lead; field tests of nicotine sulphate, pyrethrum and derris.

NEW YORK. S. W. Harman, New York (Geneva) Agricultural Experiment Station.

Field tests of six possible substitutes for arsenate of lead, of an oil spray with and without arsenate of lead; bait traps; observations on orchard sanitation.

OHIO. J. S. Houser and C. R. Cutright, Ohio Agricultural Experiment Station.

Results with summer oils, alone and with arsenate of lead; calcium and zinc arsenate and scorodite; seasonal data; population studies; larval behavior.

OREGON. Don C. Mote, B. G. Thompson, Leroy Childs and others, Oregon Agricultural Experiment Station.

Statement of present residue situation; field tests of dusting; oil sprays, with and without arsenate of lead; nicotine sulphate; calcium and manganese arsenates; calcium and sodium fluosilicates; residue removal methods; observations on banding and bait traps.

SOUTH CAROLINA. C. O. Eddy and W. T. Henerey, South Carolina Experiment Station.

Field tests of several oil sprays, magnesium, calcium and manganese arsenates.

VIRGINIA. W. J. Schoene, Virginia Agricultural Experiment Station.

Tests of calcium arsenate, toxicity to foliage, adhesiveness.

W. S. Hough, Winchester Field Laboratory.

Field tests of magnesium, calcium, and manganese arsenate, lead arsenate with calcium caseinate spreader, gypsum and hydrated lime, additional late sprays of oil or nicotine sulphate; laboratory tests of arsenate of lead against different strains of the codling moth.

W. S. Abbott and associates, U. S. Food, Drug, and Insecticide administration.

Tests of possible substitutes for arsenate of lead used against insects other than the codling moth.

WASHINGTON.

A. Spuler, Washington State College.

Results with dusts; oil sprays in part of schedule, alone and combined with arsenate of lead; nicotine sulphate; magnesium, calcium, and manganese arsenates; bait traps; residue data.

E. J. Newcomer, U. S. Bureau of Entomology.

Statement of residue situation in Washington; field tests of oil sprays, with and without arsenate of lead; nicotine sulphate; and possible substitutes for arsenate of lead; spray residue removal; bands, self-working and ordinary; bait traps and parasites.

Dr. C. H. Richardson of the Division of Deciduous Fruit Insect Investigations, Bureau of Entomology, has been giving special attention, in cooperation with the Bureau of Chemistry and Soils, to development of nicotine substitutes, with very hopeful results; Dr. F. L. Campbell, of the same division, is specializing on organic stomach poisons for insects—and progress is being made.

The Bureau of Chemistry and Soils of the U. S. Department of Agriculture has also cooperated in the work to a very important degree in the making of analyses of apples and foliage to determine the amount of arsenic and lead present, following different spray treatments.

The Bureau of Plant Industry of the U. S. Department of Agriculture has specialized in the development of efficient methods of residue removal, and has investigated many of the problems which residue removal has involved.

Dr. Alvah Peterson, in connection with studies of the oriental fruit moth, has obtained valuable data on the factors influencing emergence of the codling moth in orchards, as bearing on the usefulness of the emergence cages in trees, as a basis for timing spraying operations. His assistant, J. W. Lipp, has obtained interesting results in tests of repellants to the codling moth and peach moth—under laboratory and orchard conditions.

It is expected that detailed reports on the work will be made by the respective collaborators when the studies under way are deemed sufficiently complete for the purpose.

SPRAY RESIDUE SITUATION. It seems well to mention here the announcement made early in 1927 by the Federal Food, Drug and Insecticide Administration, that beginning with the crop of 1928 the tolerance affecting fruit entering domestic interstate commerce would be .01 grain of As_2O_3 per pound, identical with the so-called British tolerance. The tolerance referred to at various points in this report is therefore .01 grain per pound of fruit.

The results of many of the anaylses have not yet been reported, and many of those reported show numerous inconsistencies. For these reasons, a detailed tabulation of analyses will not be presented here.

In general, many sections of the West and Northwest, and a few of the more southern apple regions elsewhere, cannot with present materials and methods adequately control the codling moth without excessive residue. Spray schedules completed as early as the peak of the hatching of first brood worms are very likely to leave residues in excess of .01 grain per pound. At the other extreme, most of the apple sections in northeastern United States can control the codling moth without difficulty with spray residue. In most parts of the Middle West, and in some apple sections elsewhere, the situation is intermediate between the two extremes, and varies from season to season. Many seasons the worms may be controlled without leaving excessive residue; in other seasons the control of codling moth will involve excessive residue.

Residue Removal. Mechanical wiping has on the whole proved unsatisfactory, except where the residues were only slightly above the tolerance. Mechanical wiping has therefore given way to washing in dilute hydrochloric acid. Numerous difficulties have developed, chief among which may be mentioned: difficulty in drying the fruit after rinsing, occasional direct injury or in the calyx cavity, an injury which Fisher has shown to be caused by soluble arsenic to fruit which had been bruised or insufficiently rinsed, a little difficulty with the spread of rots and molds, and molds, and difficulty in cleaning fruit a long time after harvest, when in some cases the natural coat of wax retarded the action of the acid. These and other difficulties are rapidly being eliminated. Estimates of cost range from three to eight cents per box, figures which will probably be reduced as the process is improved and simplified.

A simple, home-made equipment for washing fruit in dilute hydrochloric acid has been developed by Hartman of the Oregon Station and a similar outfit has been found fairly effective by Burkholder.

Results of Experiments Looking to the Avoidance of Excessive Spray Residue

Insecticide Control

(a) Shortened Schedules. Since the residue analyses are incomplete and inconsistent, only general statements can be made. In northeastern United States late sprays for codling moth are unnecessary; in many parts of the West the omission of late sprays would be disastrous; elsewhere the situation is too variable for definite statements at this time.

(b) Dusts. In general, dusted fruit has been found to carry residues well under .01 grain per pound, except for occasional lots of apples which evidently had been very close to the discharge pipe of the duster. Excessive dust residue can be removed rather readily by brushing. Dusting, however, has continued to prove on the whole inadequate for the control of serious infestations. These comments apply almost as fully to the substitution of dust for liquid in the late applications. Of six reports on dusting, Haseman reported results slightly better than with liquid. Mote reported results almost as good under conditions which were unusually favorable to dusting, and the other four (Ackerman, Alden, Flint and Hough) reported results ranging from half to three-fourths as effective as liquid.

(c) Contact Materials. Oil sprays—Results very variable. On the whole, oil sprays alone shown to have a certain degree of effectiveness. A few report results with oil alone in part of schedule about equal to those obtained with lead (Ackerman, Newcomer); nine other investigators reported results ranging from fair to very poor, (Gentner, Flint, Gilmer, Hough, Mote, Alden, Eddy, Borden and Jewett). When used in combination, six reports showed that oil combined with arsenate of lead was more effective than either material used alone (Gentner, Harman, Gilmer, Ackerman, Newcomer, Mote). Two reports of poorer results with the combination (Jewett, Flint). A few reports of injury of one kind or another. Eddy reported burning of foliage: Borden, Mote and Newcomer report direct injury to fruit, as well as a reduction in size.

Several investigators have mentioned serious russeting of the fruit and other injury to the finish of the fruit. D. F. Fisher, of the Bureau of Plant Industry has cooperated with Newcomer, of the Bureau of Entomology, by making a physiological study of the influence of oil on apple trees. His report is not yet ready. When it appears, it will give valuable information on the less easily measured effects of oil sprays.

NICOTINE SULPHATE. Poor results in field reported by Gentner, Mote, Hough; fair results by Flint, Van Leeuwen, Ackerman; good results by Newcomer. In laboratory tests, Van Leeuwen reported good kill of worms placed on apples sprayed within the previous twenty-four hours with nicotine sulphate and soap. Newcomer suggests that if some material could be used with nicotine to cause it to volatilize more slowly, its value might be increased.

PYRETHRUM. Pyrethrum materials have shown promise in the laboratory (Flint, Newcomer, Van Leeuwen). Fair results in one field test (Van Leeuwen).

DERRIS. In laboratory and field tests has shown promise (Van Leeuwen.)

(d) SUBSTITUTES FOR ARSENATE OF LEAD. Since one of the most pressing needs in this problem was some material to replace arsenate of lead, arrangements were made with a chemical company to prepare sufficient quantities of a number of possible substitutes for arsenate of lead and to distribute them among the entomologists who were in a position to carry on experiments with them. A great deal of credit is due the General Chemical Company of New York City for its cooperation in the matter.

OTHER ARSENICALS. Space will not be taken to record in detail the investigators responsible for the individual tests and only the general results will be given. These will be found in Table 1.

TABLE 1. SUMMARY OF RESULTS OBTAINED WITH ARSENICALS OTHER THAN ARSENATE OF LEAD

Material	Tests reported Laboratory	Field	Effectiveness	Injury
Barium arsenate	2	2	About equal to L. A.	Severe
Zinc arsenate	4	5	About two-thirds as good as lead arsenate	Considerable injury in several of the field tests.
Zinc arsenite	5	3	Variable, about three-fourths as good as L. A.	Severe in most cases.
Tricalcium arsenate	4	5	Nearly equal to L. A.	Considerable injury in several tests.
Calcium arsenate	5	12	About three-fourths as good as L. A.	Severe in many of the tests.
Magnesium arsenate	4	12	About half as good as L. A.	Severe injury in several cases.
Manganese arsenate	3	7	About two-thirds as good as L. A.	One case of severe injury, several cases of moderate injury.
Ferric arsenate	3	4	About half as good as L. A.	Traces of injury.

Material	Tests reported Laboratory	 Field	Effectiveness	Injury
Scorodite	3	7	Almost worthless	Severe injury in one test, slight injury in others.
Aluminum arsenate	4	7	About two-thirds as good	Moderate injury in a few tests.

In addition to the materials listed in Table 1, the following materials were found in laboratory tests to be practically worthless:

Iron arsenide paste
Iron arsenate paste
Titanium arsenate
Copper arsenate

Non-Arsenicals. A few field tests with the fluosilicates of calcium, sodium, and barium have given comparatively poor results (Newcomer, Mote, Porter). In the laboratory barium fluosilicate has given results approximately equal to those obtained with arsenate of lead (Newcomer, Porter, and Van Leeuwen), and sodium fluosilicate appears to be nearly as good. If this difference is caused by a lack of adhesiveness on the part of the fluosilicates, it may be possible to find a means of overcoming the difficulty. Barium fluosilicate has given not more than traces of injury in about a dozen field tests.

A number of fluorides were tested in the laboratory (Porter). Those of barium, aluminum, calcium, magnesium, and strontium, appear to have a low toxicity. The double fluoride of sodium and aluminum, or cryolite, had a high degree of toxicity. No injury occurred in several tests. No field control tests were made.

The cyanides of copper and zinc had considerable toxicity, both to worms and to foliage (Porter).

A long list of organic compounds tested in a preliminary way by Van Leeuwen included a few which appeared to have a high degree of toxicity, but further tests are needed before it will be known whether any of them are of practical value.

Before any possible substitute for arsenate of lead can come into commercial use, however, it will be necessary to determine the margin which may exist between the amount of residue which it leaves under various conditions and the quantity which is likely to be considered deleterious to human health.

Control by Means Other Than Spraying

Banding. The work with different kinds of banding materials has given variable results and has been rather incompletely reported, making it difficult to make any statement. In two tests (Flint and Steiner) a combination fabric and paper band has given the best results. In several cases, the papers—tar paper, tarred felt, etc. have given better results than burlap; in other cases the burlap has given better results.

The development of the self-working bands has been very encouraging. The kill with these bands has varied from 50% to a complete kill (Siegler, Alden, Davis, Flint, Gilmer, Newcomer). The most effective materials appear to be beta-naphthol in combination with oil, and oils alone. The oils alone, however, are effective for only a few weeks, whereas the combination material may be made to persist throughout the season. Stomach poisons appear to have no value; evidently the worm does not swallow material removed in preparation for cocooning. The results of some of this work are being presented in detail by Siegler and his associates at this meeting.

BAIT TRAPS. The status of the bait traps continues to be about as it was a year ago. The fermenting sugar-containing solutions and fruit juices are still considered the most effective. (Borden, Davis, Harman, Mote, Yothers).

USE OF PARASITES. Little information has been received as to the utilization of parasites. Newcomer estimates that to be depended upon, the parasites should attack 99% of the eggs or larvae; otherwise spraying will be needed. A start was made in the use of *Trichogramma minutum* in Indiana by Davis and Steiner, but it is too early to report results.

SANITATION. Several cooperators report observations which add emphasis to the importance of orchard and packing shed sanitation. (Harman, Haseman, Davis.)

BIOLOGICAL STUDIES

Of vital importance is the work which Hough has done with arsenic-tolerant strains of worms, to be discussed in detail by Dr. Hough before this meeting.

Observations on larval behavior have been supplied by McIndoo, Van Leeuwen, and Davis and Steiner.

Seasonal notes have been included in most of the reports.

Submitted by,
B. A. PORTER,
on Behalf of the Committee
A. L. QUAINTANCE, *Chairman*
GEO. A. DEAN
W. P. FLINT
P. J. PARROTT
B. A. PORTER
LEROY CHILDS

Voted that the report be accepted.

PRESIDENT R. W. HARNED: The next is the report of the Advisory Committee, Entomologists and Agronomists on Research and Control of European Corn Borer.

THE REPORT OF THE JOINT COMMITTEE ON THE EUROPEAN CORN BORER

APPOINTED BY THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS,
THE AMERICAN SOCIETY OF AGRONOMY, THE AMERICAN SOCIETY
OF AGRICULTURAL ENGINEERS

The European corn borer was first discovered in the western infestation area of North America in the summer of 1920. Since then it has made a natural spread until at the present time (September, 1927) the insect occurs throughout more than 135,000 square miles of territory in the Great Lakes district of Ontario, New York, Pennsylvania, Ohio, Michigan, and Indiana. Although drastic measures are being taken to place in operation every practical agency to retard the spread and to reduce the intensity of infestation, the insect is spreading in all directions at an average rate of from 20 to 30 miles per year. In spite of this continued spread, however, the average rate of increase of the intensity of infestation has been reduced, although conditions have been favorable to such increase.

Those familiar with the habits of the corn borer, the crop losses in the principal dent corn growing district of Ontario, and the results of the extensive studies of the borer in Central Europe, are convinced that the insect is of tremendous potentiality and ranks as one of the most alarming crop pests that has ever become established in America. Threatening, as it does, the corn crop of this country, upon which the great livestock industry depends for grain and roughage, the situation presents the possibility of a national calamity which calls for the keenest knowledge of the scientist, the wisest judgment of state and federal officials, and the closest co-operation of the growers.

The committee of entomologists, agronomists and agricultural engineers co-operating wishes to endorse and give its hearty approval to the efforts that have been made to control the corn borer and to commend those engaged in directing the research, regulatory, and extension activities designed for its control. Especial commendation is given to the multitude of farmers who co-operated so splendidly in the clean-up campaign.

Before present control measures had been devised, or widely and completely applied, there was a rapid increase in the intensity of infestation. For example, in Essex and Kent counties, Ontario, the acreage of corn for grain was reduced about 80 per cent between 1924, when infestation had become severe, and 1927, the first year during which vigorous control measures were applied. When the best known control measures have been applied, the rate of increase in the intensity of infestation has been greatly reduced. For example, in Essex and Kent counties, Ontario, in 1927, after vigorous control measures were enforced, the infestation was reduced fully 50 per cent, although other factors may have helped. Likewise, in the United States, the rate of increase in 1927, after the compulsory clean-up, was less than one-fourth that of 1926, before a compulsory clean-up was generally enforced.

The committee reiterates its opinion that it will be impossible to eradicate the borer or even to prevent its spread to corn-growing areas not yet infested. However, it is believed that the compulsory clean-up of 1927 not only greatly reduced the rate of infestation increase but has been successful in preventing serious commerical losses, and that the expenditure of large funds for this purpose has been completely justified.

It is the desire of this committee to assist in every possible way to marshal all forces in an effort to give every possible support and encouragement to the extensive activities now under way. With this purpose in mind and after careful and complete investigation, the Committee suggests and recommends:

1. That the state and provincial agricultural experiment stations, the state departments of agriculture, and all other agencies interested in the welfare of agriculture give their support and encouragement to the federal governments toward a continuation of present policies in respect to quarantines, quarantine enforcement, and compulsory clean-up activities. Realizing, however, that with the continued spread of the borer, it may be necessary to modify the quarantine and scouting programs within the next few years. Scouting work in the area not known to be infested by the European corn borer, but apparently subject to infestations, should

be continued, and the scouting work should be extended further to uninfested areas in the large corn-producing states where such areas seem particularly exposed to infestations.

2. That the co-operative projects in the infested areas now underway between agronomists and entomologists of the state experiment stations and the United States Department of Agriculture to determine the best types, varieties, and strains of corn for use under corn borer conditions be continued and expanded. The work in corn breeding has shown that marked variations exist among strains of corn in their susceptibility to corn borer infestation and in their resistance to injury. This field offers promise and is worthy of greater support. Studies to determine the best time to plant different sorts to escape commercial damage should be continued and efforts made to develop strains which may be planted at the optimum time to escape severe infestation and yet yield profitable returns.

3. That similar investigations with respect to types, time of maturing, yields, etc., be carried on in the corn states not yet infested with the European corn borer.

4. That there be made, in the area of heavy infestation, an extensive field study, involving a large number of fields, of the relation of time of planting to borer infestation, this to include correlative observations on soil types, varieties, height at peak of moth flight, and earliness of maturity.

5. That the possibilities of the future ultimate value of parasites should be kept clearly in mind. To date 12 species have been introduced from Europe of which several have been recovered, indicating their possible establishment under our conditions. Five million of these parasites have been bred and liberated in the infested areas of the United States and Canada. It is recommended that the projects now underway and contemplated to introduce and establish parasites of the corn borer from foreign countries, be continued and enlarged as needed. These investigations should include a comprehensive study of the biology, host relationships, etc., of the introduced species in their native habitats and on this continent after they become adapted to North American conditions. This phase of the project should include biological studies in Europe and America to determine those species best adapted to present and contemplated control recommendations. Projects now underway to determine the biology, host relationships, etc., of native parasites of the corn borer should be continued.

6. That all of the major ecological phases of the corn borer problem be given special emphasis both at home and abroad. The reconnaisance ecological survey on which a good start has been made should be extended to embrace the entire corn belt and should at least cover the historical and present plant associations.

7. That since the problem of successfully combating the corn borer by mechanical processes depends upon a clear understanding and knowledge of the habits, life history, and environmental influences affecting its spread into new territory, as well as upon the limitations of corn as to seasonal, varietal, and cultural practices, more extensive studies of these factors should be made, particularly those which will assist the engineer in making specifications for improvements on present machines, as well as in the design of new and special machines for changing conditions.

8. That in view of the interdependence of machinery requirements and design, research work be undertaken co-operatively and experimental and research programs be correlated with federal control methods and large scale field procedure.

9. The control of the corn borer by mechanical processes is of demonstrated importance and will undoubtedly continue to be so as long as the pest remains a

menace to the corn crop of the country. Inasmuch as this method of control must continue until better methods can be found, we recommend that a comprehensive and vigorous research program relating to mechanical methods of crop production and commercial utilization be initiated by state and federal agencies.

10. We recommend particularly investigations with machinery in corn borer control along cultural, harvesting, and crop utilization lines. The use of rakes, burners, and other stalk and remnant disposal machinery and devices to supplant hand labor, should receive more attention.

11. That the experiments to determine the value of plowing under corn debris as a means of destroying the corn borer larvae should be extended. Such studies should include a determination of the comparative value of fall and spring plowing on different types of soil, on different dates and at different depths.

12. That since the burning of crop residues is one of the means used in the control of the European corn borer, studies on the effect of the burning of corn residues on soil productivity should be continued.

13. That consideration be given to the feasibility of determining on a large scale, in screened areas, the relative degrees of infestation and damage to be expected (1) where no effort at clean-up is made, (2) where the most practical clean-up methods are employed.

14. That the rural economists be urged to continue their studies of the costs of the various operations involved in the clean-up program and also on changes in farming systems in the areas affected.

15. That those engaged in research along agronomic and animal nutrition lines study rotations with special reference to determining the degree to which it may be possible or desirable to substitute less susceptible crops for corn in those sections where the corn borer promises to become a serious pest.

16. That investigations upon chemical insecticides, repellents, and attractants be continued, as well as those relating to the physiology of the corn borer and its chief host plants, especially corn.

17. That in one generation areas the study of weeds and other plants than corn be continued to determine what part these may play in the future as breeding hosts of the borer, especially in districts where, owing to the severity of the infestation, corn growing may be abandoned temporarily.

18. That the state and federal extension services take every opportunity by demonstrations, exhibits, and lectures to acquaint their constituencies with the gravity of the corn borer problem, the nature of the insect and its work, and the methods of meeting the situation. The need of the cooperation of every grower in the regions adjacent to the infested areas as well as within recognized corn borer territory should be emphasized.

19. That federal and state administrative authorities be urged to make available, at frequent intervals, up-to-date information regarding the general situation and the progress of investigations in the United States, Canada, and abroad, through the medium of bulletins, circulars, and leaflets. Also where advisable, that mimeographed statements of progress be issued at frequent intervals to technical workers.

20. That the committee act as a clearing house in advancing corn borer control measures by obtaining opinions from the entomologists, agronomists, agricultural engineers, and others, as to the lines of research and other methods which should be pursued, with special reference to needed investigations not now underway and which may have a practical application to the problems.

21. The committee recognizes that research is the basis of all progress in methods of control of the corn borer and recommends the fullest program of research along all lines offering promise of assistance and the fullest financial support for such research programs.

22. It is recommended that copies of all written reports or recommendations of the committee be made available to the Secretary of the United States Department of Agriculture and the Canadian Minister of Agriculture.

Respectfully submitted,

GEO A. DEAN	L. E. CALL	H. H. MUSSELMAN
LAWSON CAESAR	W. L. BURLISON	E. W. LEHMANN
J. J. DAVIS	J. F. COX	R. D. BARDEN
C. J. DRAKE	R. M. SALTER	
D. J. CAFFREY	F. D. RICHEY	
Entomologists	*Agronomists*	*Agricultural Engineers*

Joint Committee of Entomologists, Agronomists and Agricultural Engineers

Voted that the report be accepted.

PRESIDENT R. W. HARNED: We will now listen to the report of the Committee on Insect Pest Survey.

MR. C. R. CROSBY: I believe that Professor Hinds and I are the only members present at the meeting. When we met to prepare our report we were delighted to discover there is another Committee on the Insect Pest Survey which has gone into the matter very fully and prepared a report. Mr. Davis is chairman of that committee and I will ask him to present the report to the Association at this time.

REPORT ON INSECT PEST SURVEY

The undersigned committee of the American Association of Economic Entomologists, appointed to personally investigate the needs of the Insect Pest Survey, begs leave to report as follows:

HISTORY OF SURVEY. The Insect Pest Survey was inaugurated in 1921 at the urgent request of entomologists throughout America. The object of the Survey was to collect information on insect problems from month to month and incorporate the data in a summary or survey for the entire United States and Canada. For this purpose the Bureau of Entomology appointed Mr. J. A. Hyslop in charge of the Survey and assumed responsibility for collecting and publishing the information. One or more State Reporters were appointed from each state and they assumed the duty of collecting information on the insect situation in their respective states and forwarding same regularly to the central office at Washington. Regular mimeographed monthly summaries under the title "Insect Pest Survey Bulletin" have been issued each month, excepting the months of December, January, February and March, since 1921. In addition a "Summary of Insect Conditions throughout the United States during 1921" was issued as Departmental Bulletin 1103. This included an excellent summary account of 19 of the more important insects and is an invaluable guide which, unfortunately was not continued beyond the initial number.

ACCOMPLISHMENTS. The Bulletin has been regularly issued and has received the hearty support of practically all state workers. The entomologists throughout the United States and Canada have expressed unusual appreciation of the service thus furnished.

The BULLETIN has forewarned entomologists of possible troubles through the records of insect developments in surrounding states and has enabled them in many cases to predict and to be prepared for impending insect outbreaks.

The Survey Bulletin has been of great service by enabling entomologists in the different states to more intelligently discuss current insect problems and to more accurately answer letters of inquiry.

The Survey has been an important factor in developing a spirit of cooperation between the workers of the states and between state and federal workers.

Already the data which have been accumulated from month to month and from year to year have been used as a partial basis in forecasting insect problems and their use for this purpose will undoubtedly increase as the work is developed.

The Survey has also been of service in making its accumulated records available to workers monographing individual insects or groups of insects.

All of these accomplishments and many others have been made under a great handicap and the efforts and energy of Mr. Hyslop, in charge of the work since its organization, are highly commendable.

NEEDS. The work has been carried on by one man, assisted by one stenographer. No specific appropriations for this important work have ever been requested as it was thought desirable to give it a careful trial in a small way to determine the value of the project.

The immediate value of such a survey depends on the promptness in classifying, tabulating and publishing the information. Because of insufficient assistance there has necessarily been much delay in issuing the Monthly Bulletin and the accumulated records have not been classified and tabulated as should be done to secure their greatest usefulness.

The future value of the Survey depends on the completeness of the filing records and for reasons already given it has not been possible to make complete files of all phases of the contemplated survey work.

IT IS THEREFORE RECOMMENDED, that in view of the great value, both present and future, of the Insect Pest Survey Service, that better facilities be provided:

First, to secure more prompt publications of the Bulletin;

Second, to enable the central office at Washington to make more complete classification of records;

Third, to systematize method of making reports so that all will be more nearly comparable.

Fourth, that immediate temporary assistance be provided for the coming fiscal year if at all possible and that a definite item for the Insect Pest Survey Service be included in the budget of the U. S. Department of Agriculture of the fiscal year beginning July 1, 1928.

The present needs for the Survey service as seen by this committee include:

One entomologist in charge.
One assistant entomologist, versed in statistical methods.
One clerk.
Two stenographers.

It is further suggested that the annual summary of outstanding insect problems as given in Departmental Bulletin 1103 be continued and that special efforts be made to issue such reports without the usual delay in the publication of bulletins.

Respectfully Submitted,

W. P. FLINT
G. A. DEAN
J. S. HOUSER
J. J. DAVIS, *Chairman*

MR. J. J. DAVIS: I might say this report was written for the express purpose of submitting it to the Research Director of the U. S. Department of Agriculture, which accounts for certain details.

As we were instructed, this report was sent to Dr. A. F. Woods, Director of Scientific Work of the U. S. Department of Agriculture, and I have a reply under date of April 29, 1927, as follows:

"Thank you for the valuable report on Insect Pest Survey. I can see the great importance of this work and shall ask that it be given careful consideration in making up the budget."

We submitted this to Dr. Woods just previous to the making up of the budget, and I have since been informed that this report was effective and that a definite item in the budget has been included for the Insect Pest Survey, and additional funds are available for this work. (Applause)

Voted that the report be accepted.

MR. W. E. HINDS: I would like to ask Mr. Hyslop whether it is possible that mimeographed copies could be sent to county agents who are interested enough to request them.

MR. J. A. HYSLOP: We have certain mimeographed publications which have come out. As to the number of copies that will be issued, we have already passed that number by about 200 copies, and I fear it would be it quite impossible to attempt to send mimeographed copies to each county agent in the United States. It would be rather a bad precedent to start.

PRESIDENT R. W. HARNED: The next report is that of the Representative to the International Zoological Congress at Budapest, Hungary.

MR. L. O. HOWARD: I placed in the hands of the Secretary a plain, typewritten report signed by both of your delegates, Dr. J. M. Swaine and myself, and inasmuch as I am going to talk a little bit about the zoological congress at dinner tonight, I think we might spare the reading of that report. I can assure you, sir, if you will accept it in the order it is printed, there is nothing dangerous in it.

THE TENTH INTERNATIONAL ZOOLOGICAL CONGRESS

The Tenth International Zoological Congress was held at Budapest, September 3–10, 1927. It was the first one held since the one at Monaco in 1913. From our point of view it was especially notable, since an entomologist, Dr. G. Horvath, was the President. There were somewhat over seven hundred persons in attendance, and nearly all of the sessions were crowded. Doctor Horvath presided in a very efficient way and was very active not only throughout the Congress but in its preparation.

Since the establishment of international entomological congresses the zoological congresses have been perhaps slightly less attractive to working entomologists. Nevertheless, there was a very considerable number in attendance at Budapest, mainly, however, from the surrounding countries. Comparatively few Americans were there.

Altogether, 254 papers were presented, of which 35 treated of entomological topics. In the general sessions (six in number) twenty-five addresses were made, only one of which was concerned with entomology, viz., a very interesting talk by Dr. J. Komarek of Prague, on the work against the nun moth with airplanes, illustrated by moving pictures. Of the remaining 34 papers, 12 were read before Section VII on applied zoology. As a matter of fact, all of the papers read before this section were of an entomological character. Before Section VI (Arthropoda) 14 entomological papers were read; and before Section VIII (paleo-zoology and zoo-geography) eight papers were presented. Of the latter, one by Jaczewski related to the fossil Corixidae of Boryslaw, Poland, and the rest (by Vandel, Navas, Czekelius, Muller, Kiss, Barteneff, and Uvarov) treated of some aspect of geographical distribution of insects. The American entomologists who read papers were Alfred Emerson, W. R. Thompson, R. N. Chapman, J. M. Swaine and L. O. Howard, all of these papers being distinctly economic except that of Doctor Emerson. A paper was also read by Dr. T. U. H. Ellinger, of Chicago, detailing the efforts he had made under a private fund to secure cooperation of certain European biologists in working out important points relative to the European corn-borer. The other papers on economic entomology were presented by Jablonowski, Bako and Kadocsa, of Budapest; Rambousek, of Prague; Langhoffer, of Zagreb; Prell, of Tharandt; Stichel, of Berlin, and Evenius, of Stettin.

The arrangements for the Congress were very adequate, with the single exception of the registration facilities. Registration was carried on with considerable inconvenience in a very small room with only one entrance. It is a prime desideratum in all large congresses that especial attention should be paid to this point. In every case the registration room should be very large and should have two or more entrances or exits.

The City of Budapest entertained all of the members of the Congress and their families at a formal banquet at the largest hotel in the city, and there were numerous excursions to points of zoological interest. The people of Budapest were wonderfully hospitable, and the Congress will go down to history as extremely successful.

L. O. Howard
J. M. Swaine
Delegates

President R. W. Harned: If no action is necessary, we will consider the report accepted.

The next is the report of the Committee on Amendment to the Constitution.

REPORT OF COMMITTEE ON AMENDMENT TO THE CONSTITUTION

Your committee has given careful attention to the Amendment to Section 1 of Article 3 of the constitution of the association proposed by the executive committee in its annual report a year ago at Philadelphia. The executive committee as now constituted is composed of the president and the vice presidents and the secretary of the association. It is therefore composed of seven members, the terms of six of whom last for only one year. Only one member of the executive committee holds over from one year to the next. The proposed amendment provides that the secretaries of the sections or branches shall be added to the executive committee, the purpose being to have the committee so constituted that a larger proportion of it's membership shall hold over from one year to the next and who shall have the advantage of the experience of one or more years in the management of the affairs of the Association.

Your committee believes that the purpose of the amendment is good, but that it does not go far enough and would introduce a very objectionable feature. If the amendment is adopted, the membership of the committee will be increased from seven to eleven, five of whom or less than a majority, will hold over from one year to the next. The committee believes that at least a majority of the executive committee should hold over. Again if the amendment is adopted, the committee will be increased by two members every time a new section or branch affiliates with the Association and eventually will become too large for practical purposes. The committee therefore recommends that the proposed amendment be not adopted.

Your committee believes that the executive committee as now constituted is too transitory for best results. It believes that the membership should be limited to a definite number, that the term of office should not be less than three years and that at least a majority of the members should hold over from one year to the next. It therefore proposes the following amendment to section 1, of Article 3 of the constitution to be acted upon at the next annual meeting.

That section 1 of article 3 of the constitution shall be amended by striking out the whole of said section 1 of article 3 and substituting therefor, the following:

The officers shall consist of a president, one vice-president, and an additional vice-president for each branch or section, who shall be elected annually, and a secretary who shall be elected for a term of three years, who shall perform the duties customarily incumbent upon their respective offices and as defined in the By-laws. *The president and the last two ex-presidents and the secretary of the Association together with three members, one of whom shall be elected annually for a term of three years shall constitute the executive committee, provided that at the first election after the adoption of this amendment three persons shall be elected as members of the executive committee, one for one year, one for two years, and one for three years, and provided further that on the adoption of this amendment the retiring president shall retain membership on the executive committee for two years after the expiration of his term and the ex-president who next preceded him shall be a member of the committee for one year. The executive committee* shall pass on any urgent matters that can not be deferred until the annual meeting. The president shall not hold office for two consecutive terms.

Respectfully submitted,

P. A. Glenn
F. L. Thomas
A. F. Burgess
Committee

Voted that the report be adopted.

President R. W. Harned: The next is the report of the Committee for holding the Fourth International Entomological Congress in America.

REPORT FOR THE COMMITTEE ON THE FOURTH INTERNATIONAL CONGRESS

It will be remembered that at the last meeting of the Association a committee from this body, consisting of W. J. Holland, Herbert Osborn, J. G. Needham and the writer, submitted a report which was adopted and which contained a resolution inviting the Permanent Committee on Entomological Congresses to hold the Fourth International Entomological Congress at Ithaca, New York, in August, 1928. The report also contained a resolution, which was adopted, to the effect that this committee should be continued to act in cooperation with a committee from the Entomological Society of America (consisting of F. E. Lutz, P. P. Calvert and E. D. Ball) to consider further details connected with the Congress.

Following this action (and a similar one was taken by the Entomological Society of America) a local committee was formed at Ithaca, of which Dr. J. G. Needham is chairman and Dr. O. A. Johannsen is secretary, which began to work immediately on preparations for the Congress.

Dr. Karl Jordan, the Secretary of the Permanent Committee, was in the United States in May and June; and early in June, at Ithaca, he met with the full committee and with the chairman of the joint committee of the two organizations previously mentioned.

On account of the experience and efficiency of the members of the local committee, it has not been found necessary to call upon the members of the committee of the cooperating societies for active work, but solely for advice. Nevertheless, it should be mentioned here that one of the members of the committee of this Association, Dr. W. J. Holland, has been of great service to the committee, and that largely through his instrumentality certain funds have been contributed which will be of assistance in assuring the attendance of a certain number of foreign delegates.

The chairman of the joint committee visited different parts of Europe during July, August and September, last, and interviewed many prominent European entomologists. He found that much interest in the coming Congress exists in entomological circles in Europe; that a number of men are making an effort to arrange their plans in order to be present. The general feeling, however, is that it will be extremely difficult for European entomologists, especially those living in countries where the monetary exchange is very unfavorable, to undertake the expense of so long a journey.

It is understood that Professor Herrick, of the local Ithaca committee, will be present at this meeting and that he will present an informal report of the work of that committee.

Respectfully submitted,

L. O. Howard, *Chairman*
W. J. Holland
Herbert Osborn
J. G. Needham
Committee

Voted that the report be accepted.

President R. W. Harned: We will now have some remarks from Professor Herrick in regard to the Fourth International Entomological Congress.

THE FOURTH INTERNATIONAL ENTOMOLOGICAL CONGRESS

The Fourth International Entomological Congress promises to be the most important entomological gathering ever held in this country. We are now assured, I believe, of a good attendance by European entomologists which is the one thing necessary to make it a truly international conference.

The local committee, in consultation with American entomologists in various phases of the Science, has formulated a tentative program based largely on the program of the Congress in 1925 at Zurich, Switzerland.

Following the custom of other Congresses and of the Plant Congress held at Ithaca in 1926, the committee decided that all papers on the program should be by invitation only. In accordance with that plan most of the outstanding foreign entomologists have already been invited and acceptances are slowly coming back to us. The invitations to American entomologists for papers are waiting somewhat on the acceptances of the Europeans but are being sent out as rapidly as possible in order that everyone will have ample time in which to write a paper. We hope to have a tentative program to present for your information early in the coming year.

Now that we have been given rather satisfactory provision for assuring the presence of foreign entomologists at the Congress we desire to turn our attention to the entomological workers in this country and to urge you to attend and aid in making the Congress a truly great conference. It is your Congress in a larger sense and its success will depend on you and your enthusiasm and presence in Ithaca from August 12 to the 18th. We are receiving evidence every day of the absorbing interest of foreign entomologists in the work, especially the economic and the ecological work of the American entomologists, and we feel that a really great opportunity has come to us.

We have planned to spend one whole day at the New York Experiment Station at Geneva where Mr. Worthley has promised to have a demonstration of airplane dusting, of high power spraying outfits, and of farm machinery used in the clean-up campaign of the European corn-borer. The summer meeting of the New York Fruit Growers will also take place at Geneva on that day which will afford an example to the foreign visitors of the interest shown by the farmers of this country in entomology.

The question of finances is always an important and insistent one. We are proposing to entertain the foreign visitors while they are here to the extent, at least, of furnishing them with lodging free of cost. In addition we are arranging, if the weather permits, for one or two picnic excursions to some interesting points in the vicinity of Ithaca which we hope will please all of us. For these projects we shall need money and to meet this need we have appealed to some of the larger and more prosperous entomological societies in the United States and Canada. The response has been very gratifying. The Entomological Society of Philadelphia will, I understand, contribute probably $150.00 or more, while the Ontario Society has already, at least, $100.00 for the cause. Our own little Jugatae has already collected something over $100.00 and other societies are getting actively at work in this direction. We hope this Society and the Entomological Society of America will each contribute a generous amount so that we shall finally have a working capital, if possible, of at least $1,000.00.

A final word regarding accommodations, will perhaps interest you. The very attractive women's Dormitories, Sage College and Prudence Risley Hall, and the rooms in Cascadilla Hall, have been put at our disposal by the University. In these halls you will find most excellent accommodations at very reasonable rates. In addition, there are many good people in Ithaca who take care of thousands of students during the regular sessions of the University and who will be glad to receive an extra dollar or two from you visiting entomologists and who will in return therefor furnish excellent, quiet, comfortable sleeping quarters. You will also find convenient restaurants, cafeterias, dining-rooms, lunch rooms, quick lunches, all-night lunches and any other variety of food dispensary you desire.

Although the University has never allowed campers on the Campus because of the great American fetish of "Keep off the grass" we hope to find a convenient, suitable field somewhere on the College farm where those who wish can pitch their tents and live in the latest style of the great nomadic throng of gas-engine drivers that crowd the highways and byways of this continent.

I believe we can assure you one and all of comfortable living quarters while you are in Ithaca together with sufficient and nourishing food and we certainly hope you will all come and make this Congress of yours the best that has yet been held.

GLENN W. HERRICK

PRESIDENT R. W. HARNED: I will now announce the appointment of the following committees:

Committee on Nominations: A. F. Satterthwait, E. R. Sasscer and L. S. McLaine.

Committee on Resolutions: W. C. O'Kane, A. C. Baker and S. Marcovitch.

As an additional member of the Membership Committee to take the place of Harry Smith, who is not here, H. F. Dietz.

First Vice-President W. P. Flint assumed the Chair.

FIRST VICE-PRESIDENT W. P. FLINT: The next item is Miscellaneous Business.* Is there any miscellaneous business that should come before the Association at this time?

If not, the next item on the program is that of New Business. Is there any new business to be brought before the Association at this time?

SECRETARY C W. COLLINS: I have a communication from the Permanent Secretary of the American Association for the Advancement of Science that the Committee on Awards wishes suggestions as to outstanding papers presented at this Nashville meeting. This Association is invited to make recommendations If any of you members see any outstanding papers and wish to draw up recommendations, we will be glad to consider them and forward them to the committee. The author need not be a member of the American Association for the Advancement of Science.

FIRST VICE-PRESIDENT W. P FLINT: Is there any other new business?
(At this point the annual address of the President was delivered which appears in Part II)

FINAL BUSINESS

The final business was transacted Friday afternoon, December 30.

PRESIDENT R W. HARNED: Before we proceed to the final business, I am going to ask Dr. Howard if he will be kind enough to make a few remarks in regard to the collection of photographs of entomologists which is being made at Washington at the present time

MR. L. O. HOWARD: I have asked for photographs by correspondence. This, again, is sort of a personal fad of mine, but it has developed into a great national collection of international scope We already have about 1600 photographs of entomologists. It is not intended to include solely the men who have already made their mark I have restricted it only to the active members of the organization, but I wish also the associates, because, who knows, any of them, perhaps all of them, will some day become men of great attainment. See what an interesting start it will be to have photographs showing them in their infant stage. (Laughter) I want every man to send me a photograph of his body and soul and also to urge his associates to send theirs as well.

PRESIDENT R. W. HARNED: I believe Dr. DeLong has something to bring before the Association at this time.

MR. D. M. DELONG: In talking over the matter with some of the other entomologists present, we thought it would be an excellent thing at this time to send to Professor Comstock a note of our regret and sympathy. I wish, therefore, to present this as a night letter to be sent by the Secretary, if it is approved by the Association:

"The American Association of Economic Entomologists in session at Nashville regret greatly to hear of your illness, and hope for your rapid and complete recovery. We send greetings and best wishes to you and Mrs. Comstock, and assure you that this is accompanied by the sincere appreciation and love of all entomologists."

The motion was carried by a rising vote.

PRESIDENT R. W. HARNED: We will now call for the report of the Committee on Resolutions.

REPORT OF RESOLUTIONS COMMITTEE

The Resolutions Committee transmits and endorses the following communication from the Committee on Policy:

The American Association of Economic Entomologists desires to place on record its appreciation of the work of the United States Department of Agriculture in establishing field stations in foreign countries for the purpose of studying insect pests, plant and animal diseases already introduced or likely to be introduced into this country. Each year has emphasized the value of this policy and the desirability of its further extension. We urge that additional support be provided for the immediate extension of this very important work. It is recommended that the incoming President appoint a committee of three and that the American Phytopathological Society be requested to appoint a similar committee to present the needs for the further development of these projects to the Secretary of Agriculture.

The Resolutions Committee presents the following:

Resolution on Acknowledgments.

Acknowledging gratefully the fact that this meeting of the American Association of Economic Entomologists has been second to none in the thorough arrangements provided for its work and entertainment, and that it will stand out as one of the most interesting, enjoyable and profitable meetings in the history of the Association.

BE IT RESOLVED, That the secretary of this Association be instructed to convey its very hearty and sincere thanks to each of the following:

G. M. Bentley, A. C. Morgan, R. W. Leiby, O. I. Snapp, J. M. Robinson, R. W. Harned, and President H. A. Morgan; The Cotton States Branch of the American Association of Economic Entomologists: The Nashville Chamber of Commerce, and especially its secretary, V. P. Porter; Vanderbilt University, and especially Dr. J. P. Kellar and Dr. Geo. R. Mayfield; The Y. M. C. A. Graduate College; Peabody College; Scarrett College; Ward-Belmont College;The newspapers of Nashville; The Boy Scouts of Nashville.

The Resolutions Committee presents the following Resolution on Training of Entomologists:

Recognizing the fact that entomology is a living science and its practice a developing profession; That positions to be filled by entomologists grow constantly more specialized; That training for such positions must prepare adequately in relatively new and specialized fields of entomology. That adequate groundwork in the broader aspects of entomology and related sciences remains essential; That under these conditions readjustment of the items of training becomes necessary from time to time; That continual study of the problem is essential in order that training may become and remain equal to the demands made upon the man entering entomology; That such study may wisely include the experience and point of view of men employing entomologists;

BE IT RESOLVED, That the incoming president of this Association appoint a committee of five men who are in the position of employers of entomologists in various fields of the profession, this committee to confer upon the requirements of the several fields, as well as the essentials of foundational training, and to present to this Association at its next meeting a tentative list of subjects that should be included in the training of an entomologist, including both foundational and specialized items, with their proportionate weight in such training.

W. C. O'KANE
A. C. BAKER
S. MARCOVITCH
Committee

MR. W. C. O'KANE: The Committee presents as its first resolution one handed to it by the Committee on Policy, and carries the further signatures of the Committee on Resolutions.

Voted that the first resolution be adopted.

MR. W. C. O'KANE: The second resolution is one we have great pleasure in presenting.

Voted that the second resolution be adopted.

MR. W. C. O'KANE: The next resolution is on training of entomologists.

Voted that resolution No. 3 be adopted.

MR. W. C. O'KANE: The 4th resolution has to do with the program and is more a matter of terminology than it is otherwise. We think it is not in conflict with the wishes of the Committee on Program but is intended to specify better what a five-minute paper is.

The resolution recommended that a summary of not more than 500 words be prepared and presented as an abstract at the meeting instead of the present limitation of 5 minutes. This was presented as a suggestion for consideration by the program committee.

This resolution led to considerable discussion, it being the consensus of opinion that it was better to adhere to the time limit, allowing the author freedom to use the time in whatever way was considered best.

It was voted that this resolution be laid on the table.

PRESIDENT R. W. HARNED: Next is the report of the Committee on Membership.

REPORT OF COMMITTEE ON MEMBERSHIP

The Committee on Membership submits the following report:

1. It recommends for election to associate membership the following 74 persons:

Anderson, W. E.
Ballou, C. H.
Bare, C. O.
Beal, J. A.
Bibby, F. F.
Bliss, C. I.
Bruce, W. G.
Burrell, R. W.
Butcher, F. G.
Carpenter, H. H.
Clark, S. W.
Cowan, F. T.
Davis, C. N.
Denberry, E. P.
Ditman, L. P.
Drury, C. W.
Ficht, G. A.
Gaines, J. C.
Glover, L. C.
Grady, A. G.
Graham, Castillo
Gray, John
Green, C. E.
Grimes, M. L.
Hall, D. G.
Harlan, W. R.
Henercy, W. T.
Hering, P. E.
Herr, E. A.
Hills, O. A.
Hines, Chesley
Howard, Samuel
Hull, F. M.
Irish, C. F.
Jones, S. C.
Keck, C. B.
Kile, H. J.
Kirkpatrick, A. F.
Livingston, B. P.
Lyon, S. C.
McAlister, L. C., Jr.
McCampbell, S. C.
Martin, C. H.
Meacham, F. B.
Melvin, Ray
Metzger, F. W.
Morofsky, W. F.
Moser, J. C.
Neiswander, R. B.
Nichol, A. A.
Norris, R. K.
Owen, W. L.
Parker, W. B.
Riley, H. K.
Roberts, R. A.
Russo, Giuseppe
Ryberg, M. E.
Savage, J. R.
Sheaffer, F. E.
Sheldon, H. B.
Smith, F. A.
Symonds, C. M.
Thompson, W. L.
Thomson, J. R.
Toyne, Arthur
Ulman, P. T.
Walker, H. G.
Wallis, R. L.
Wagner, G. B.
Wardle, R. A.
Wheeler, A. J.
Woodhams, G. E.
Yeomans, M. S.
York, C. H.

2. The committee recommends that the following 42 associate members be transferred to active membership:

Alexander, C. P.
Barnes, D. F.
Bigger, J. H.
Brannon, L. W.
Broadbent, Bessie M.
Brown, Luther
Bulger, J. W.
Carter, Walter
Chambers, E. L.
Douglass, J. R.
Eddy, C. O.
Ellington, G. W.
Evenden, J. C.
Fisher, C. K.
Fleming, W. E.
Friend, R. B.
Granovsky, A. A.
Harris, H. M.
Howell, P. A.
Hutson, Ray
Kimball, H. H.
Jacobson, W. C.
Langford, G. S.
Lewis, H. C.
Lyle, Clay
MacLeod, G. F.
McClendon, S. E.
Mickel, C. E.
Noble, W. B.
Painter, H. R.
Patch, L. H.
Reed, W. D.
Richmond, E. A.
Schweiss, G. S.
Searls, E. M.
Smith, F. F.
Stirrett, G. M.
Swingle, H. S.
Vance, A. M.
Van Leeuwen, E. R.
Wallace, F. N.
Willard, H. F.

3. The committee recommends that the following persons be re-instated to associate membership:

Fletcher, R. K.
Gray, G. P.
Hoke, Gladys
Moulton, Dudley
Pack, H. J.
Sams, C. L.
Snow, S. J.
Stene, A. E.

4. The committee recommends that the resignations of the following members be accepted:

ACTIVE	*ASSOCIATE*
E. M. Ehrhorn	Armstrong, G. M.
	Boyd, G. W.
	Dobroscky, Irene D.
	Needham, P. R.
	Pinckney, J. S.

5. The committee recommends that the dues of J. H. Merrill, an Active member, be remitted for the years 1927 and 1928.

6. The committee recommends that C. L. Marlatt and R. W. Harned, be admitted to Life Membership.

7. The committee recommends that Friedrich Stellwaag, Associate member, be transferred to Foreign membership.

HARRY S. SMITH
J. A. HYSLOP
HARRY F. DIETZ (pro tem)
DWIGHT M. DELONG
Committee

MR. L. O. HOWARD: What about life members, do we have any?

SECRETARY C. W. COLLINS: We have five to date: three voted in previously and the two recommended in the list just read.

Voted that the report be accepted and the recommendations adopted.

PRESIDENT R. W. HARNED: Are there any other committees to report at this time? Is the Advisory Committee of the Journal ready to make nominations?

MR. J. W. MCCOLLOCH: I am the only member of the Advisory Committee of the JOURNAL present; however, I would like to nominate E. P. Felt as Editor, W. E. Britton as associate editor and C. W. Collins as business manager. I am sure the rest of the Board concur with me in the recommendation.

Voted that the report be accepted and the recommendations adopted.

President R. W. Harned: The next is the report of the Committee on Nominations.

REPORT OF COMMITTEE ON NOMINATIONS

President: W. B. Herms.
First Vice-President: J. E. Graf.
Vice-President (Pacific Slope Branch): R. S. Woglum, Los Angeles, Calif.
Vice-President (Cotton States Branch): G. M. Bentley, Knoxville, Tenn.
Vice-President (Eastern States Branch): P. J. Parrott.
Vice-President (Section of Plant Quarantine and Inspection): L. S. McLaine.
Vice-President (Section of Apiculture): H. F. Wilson.

Standing Committees

Committee on Policy: R. W. Harned, A. and M. College, Miss., 1932.
Membership: Harry F. Dietz.
Advisory Board: W. F. Brittain, C. L. Metcalf.
U. S. National Museum: Harry H. Knight.
Board of Trustees for Permanent Fund: R. W. Doane.
Councillors for the American Association for the Advancement of Science: George A. Dean, Glenn W. Herrick.
Trustees for Crop Protection Institute: W. P. Flint.
Representatives on Council of Union of American Biological Societies: A. L. Quaintance, C. R. Crosby.
Representative on Board of Trustees of Tropical Plant Research Foundation: Herbert Osborn.

The Committee respectfully renominates the present personnel of the following Committees and recommends that the Association specify the plan of determining the expiration of term of each member of the several Committees, on: Nomenclature, Insect Pest Survey, Research Work on the Control of the European Corn Borer, Program, Endowment Fund, Research Work on Biology and Control of the Codling Moth.

A. F. Satterthwait, *Chairman*
E. R. Sasscer
Leonard S. McLaine
Committee

Voted that the report be accepted and the nominees elected.

President R. W. Harned: I believe that Vice-President Bentley is the highest ranking officer of the new administration present. I will ask Past Presidents Quaintance and Burgess to escort him to the Chair.

Past Presidents Quaintance and Burgess escorted Mr. Bentley to the Chair.

President R. W. Harned: Professor Bentley, I predict your administration will be the most successful that the Association has ever had. (Applause)

Vice-President G. M. Bentley assumed the Chair.

VICE-PRESIDENT G. M. BENTLEY: The next matter, as I understand it, is miscellaneous business.

MR. L. O. HOWARD: While the report of the Committee on Resolutions included the simple words R. W. Harned, I am not content to let the matter rest there. I, therefore, move, sir, that the Association resolves it owes much of the success of this meeting to the tact, courtesy and efficiency of the retiring President, Mr. Harned. (Applause)

VICE-PRESIDENT G. M. BENTLEY: Is there any other miscellaneous business?

MR. WILLIAM MOORE: Something further on the presentation of papers: I was wondering whether it would be possible to have the Program Committee empowered to pass on certain papers. That is, suppose a member had a paper which he considered of national importance, and it was one which could not be condensed readily to five minutes, and he wanted ten or fifteen minutes. He could have it presented to the Program Committee in advance. The Program Committee might permit one or two such papers for each meeting. I just give that as a suggestion, not as a motion, and would like to know if anybody else has any ideas along that line.

VICE-PRESIDENT G. M. BENTLEY: Is there any further miscellaneous business?

MR. C. L. METCALF: There is one thing, it seems to me, has spoiled the perfect arrangements for these meetings, and that is the equipment provided for projection. I don't know whose business it is, but certainly this Association ought to outlaw the daylight projection which has been inflicted upon us for the past several years as a substitute for our former dark-room projection.

A number of members have come with their data condensed on lantern slides in an effort to save time and make their presentation, and it has been completely ruined by our inability to project far enough for anyone to see. I don't know what to suggest, but it ought to be brought to the attention of those who make arrangements for future meetings that we will not be satisfied with this type of projection.

VICE-PRESIDENT G. M. BENTLEY: In regard to local arrangements for this meeting, would say that the furnishing of lanterns and screens was given over to the Bausch & Lomb people. We looked to Dr. Kellar for meeting rooms and it would seem to me that this matter would come within the scope of duties of the Secretary for adjustment.

Is there anything else?

MR. J. J. DAVIS: Ever since the dinner a few evenings ago I have been thinking over a remark made regarding the need of—I don't know whether we call it publicity, but I might use that term—publicity of entomology. I think there is a greater need. I will agree we have had sufficient publicity on the corn borer, but, regarding other matters, we could utilize to advantage additional publicity. I believe the A. A. A. S. is not giving the entomological sections sufficient satisfaction in publicity of the meetings.

It seems to me we could, to very great advantage, have a publicity man whose business it would be to present matters of publicity to the local and associated press. I would like to suggest that this matter be given some consideration by the Committee on Policy.

VICE-PRESIDENT G. M. BENTLEY: I think that is extremely timely and very important.

MR. A. F. BURGESS: I am thoroughly in sympathy with what Professor Davis has said. I would suggest that you refer it to the Executive Committee rather than the Committee on Policy, because they could take action, if it reacted favorably, in time to put the matter in operation for the next annual meeting. I understand it is to be in New York City. It will probably be a larger meeting. An arrangement of that sort seems to be of big benefit to the Association and all concerned. It could be worked out for the 1928 meeting.

VICE-PRESIDENT G. M. BENTLEY: Professor Davis, was that in the form of a motion or suggestion?

MR. J. J. DAVIS: It was in the form of a suggestion, but I will make a motion to that effect.

The motion was seconded and carried.

VICE-PRESIDENT G. M. BENTLEY: The next is fixing the time and place of the next meeting.

SECRETARY C. W. COLLINS: I recommend that the time and place of the next meeting be the same as that of the A. A. A. S., namely: New York City in December.

VICE-PRESIDENT G. M. BENTLEY: Before we adjourn there is one matter I want to take up. I am sorry the higher officer is not here to present this, but I want to say the Cotton States Entomologists have been very proud of the opportunity they have had presented to them of having their many friends as their guests for a few days.

There are so many who have taken an active part in accomplishing the few things that have been attempted, that time would not permit me to mention all of them, but I wish to refer to a few at this time. Among those, I mention first Professor Harned; second, Mr. Oliver Snapp and third I wish to mention Mr. A. C. Morgan, then the assistants from the three states that those men represent as well as the assistants we have here in Tennessee, as being men who have helped put over the few things we have had on the side. We are very proud to have had you in the new South. We hope you will carry away good impressions and that you will come back to us when the opportunity presents itself.

MR. W. E. HINDS: Before the meeting adjourns I think it may be in order to state that the Cotton States Entomologists are going to hold an adjourned session at Memphis, February 1, 2 and 3 in connection with the annual convention of the Southern Agricultural Workers, and we would like to say that all entomologists, whether members of the Cotton States Branch or not, will be extremely welcome at that gathering.

MR. P. J. PARROTT asked for and secured favorable consent of the members of the Eastern States Branch during the meeting to hold the next summer meeting of that Branch at the time of the International Congress of Entomologists which will be held at Ithaca, N. Y., August 12 to 18, 1928, and not to have a trip through the Hudson River Valley, N. Y., as originally planned.

VICE-PRESIDENT G. M. BENTLEY: Is there any further business? If not, a motion to adjourn is in order.

ADJOURNMENT: 3:25 o'clock.

PART II. ADDRESSES, PAPERS AND DISCUSSIONS

The address of the President was delivered at the close of the afternoon session, Wednesday, December 28, Vice-President W. P. Flint in the Chair.

VICE-PRESIDENT W. P. FLINT: The next item is the Annual Address of the President, R. W. Harned.

ENTOMOLOGY IN THE SOUTHERN STATES

By R. W. HARNED, *Entomologist, A. & M. College, Mississippi*

ABSTRACT

A brief resumé of entomology in the eleven Southeastern states known as the Cotton States is given together with a study of the distribution of entomologists throughout the United States. Brief mention is made of the early development along entomological lines, including the organization of the Cotton States Entomologists. Tabulations indicate the activities at the present time along the lines of research, teaching, extension entomology, regulatory work, and insect collections. Among the other subjects discussed are: the relation of insects to economic and industrial progress in the Southern States; some of the important entomological achievements in this region; and the confidence that is placed in the entomologists by the public. A brief tribute is paid to the service given by amateur entomologists, and an optimistic forecast is given regarding the future of entomology in this region.

This discussion is not presented with an exaggerated opinion of the importance of Southern contributions to entomology, but the subject was suggested by the fact that one year ago today when this Association was holding its 39th annual meeting in Philadelphia, a report was submitted that contained the following recommendation:[1]

> That the place of the next annual meeting be left in the hands of the Executive Committee, with the suggestion that they consider the advisability of holding the annual meeting at a different time or different place from the regular meeting of the American Association for the Advancement of Science.

A similar recommendation was made to the Entomological Society of America.

The members from the Southern States had been anticipating for several years the opportunity of having with them in the South the entomologists from the Northern and Western States and from Canada. Some had been anticipating the opportunity of attending these meetings without the expenditure of so much time and money as had been required of them for years in attending the meetings in the North and Middle West. Others in this region, who had never had the opportunity of attending the meetings because they were usually held so far away, were looking forward to the privilege of meeting many entomologists from other sections of this country and Canada. Therefore the suggestion that we might not meet at Nashville came as a surprise and disappointment to the members from this section of the country.

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[1] After presenting this address the author learned that he had misinterpreted the purpose of this recommendation, which was really intended to propose that the Executive Committee consider the advisability of holding an annual meeting apart from the general meetings of the American Association for the Advancement of Science as a meeting of entomologists only. This resolution was not approved by the Association.

Instead of holding the annual meetings less often in the Southern States, some of us had been hoping that with the growth and development that the South has been making along all lines during recent years, we might hope to have these meetings held in this region more frequently.

Thirteen years had passed since the 26th annual meeting was held in Atlanta in December 1913, which was the last meeting held in this section of the country. It had been known for several years that the American Association for the Advancement of Science would meet this year in Nashville. It had been an unbroken precedent since 1891 for this Association to meet at the same time and place as the American Association for the Advancement of Science, while the Entomological Society of America had always since its organization in 1906 met with that Association.

Why was it that some of our members preferred not to have this meeting held in the South?

In reply to my casual inquiry, one stated that he thought the meeting should not be held in the South because it was so far away that most entomologists could not afford to spend the necessary time and money for the trip. Probably his real impression was that there were so few entomologists in the South that they could scarcely be considered in making plans for the annual meetings. Another was in favor of holding this meeting further North because Nashville was so far from any important entomological activity, and a third suggested that there were so few entomologists in the South that the attendance would be very small.

These incidents that occurred in Philadelphia a year ago impressed me with the fact that some of our members apparently had little appreciation of what had been accomplished along entomological lines in the Southern States, as well as the entomological progress now being made in this section of the country.

In referring to the Southern States I have in mind those states that are generally known as the Cotton States. The Cotton States Branch of this Association is composed of the members in eleven states—North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Tennessee, Arkansas, and Oklahoma. Geographically they are the Southeastern States of the United States.

GEOGRAPHICAL DISTRIBUTION OF MEMBERS IN THE NATIONAL ENTOMOLOGICAL SOCIETIES

As the suggestion had been made that there was so little interest in entomology and so few entomologists in the Southern States, that even though 14 years had passed since the last previous meeting in this section of the country, it would be advisable to meet elsewhere, although to do so would break a precedent of 36 years of meeting annually with the American Association for the Advancement of Science, it occurred to me that it might be of interest to determine if possible in what states there really exists the greatest interest along entomological lines. Various means of gauging the entomological interest in the different states were considered. It was decided that possibly the distribution of the membership of this Association might be about as satisfactory a method as any to determine the relative interest in entomological matters throughout North America. As it would seem that the entomologists would not be likely to become members of an organization that seldom or never held its meetings near enough for them to attend, and since most of our meetings had been held in the Eastern and Northern States, it appeared that the Southern and Western States might be at a disadvantage if our membership was used as the gauge to determine entomological interest. Certainly the advantage, if any, would be with the sections where most of the meetings have been held. However, a study of the distribution of our membership revealed some interesting facts.

Although this Association has never held a regular meeting in or near California, and although there are seven states that have larger populations, California has the largest number of members in the Association. Knowing something of the great progress that California has made along entomological lines, and the many leading entomologists that reside in that state, it was really not surprising to find California heading the list. It was a surprise, however, to learn how far she was in the lead of states with much greater populations. It was also surprising to find that Florida, Louisiana, and Mississippi, were leading such states as Kansas, Connecticut, Iowa, Missouri, and Minnesota. Considering the great achievements of Canadian entomologists and the outstanding leaders from that Dominion, it was a surprise to find that Canada has only 34 members. Our members in the United States and Canada are distributed as follows:

	Members		
State	**Active**	**Associate**	**Total**
California	39	48	87
New York	25	34	59
Massachusetts	27	31	58
District of C.	43	15	58
Ohio	16	25	41
Mississippi	6	30	36
Pennsylvania	18	18	36
New Jersey	14	16	30
Louisiana	9	15	24
Illinois	14	9	23
Texas	8	15	23
Florida	12	10	22
Kansas	8	12	20
Virginia	7	9	16
Connecticut	10	5	15
Iowa	9	6	15
Michigan	5	8	13
Missouri	4	9	13
Oregon	6	7	13
Tennessee	6	7	13
Wisconsin	4	9	13
Georgia	5	7	12
Indiana	6	6	12
Minnesota	7	5	12
North Carolina	6	5	11
Arizona	3	7	10
Colorado	6	4	10
South Carolina	3	7	10
Washington	7	3	10
Utah	4	4	8
Arkansas	3	4	7
Idaho	1	6	7
Maryland	5	2	7
Montana	5	2	7
West Virginia	4	3	7
Alabama	1	4	5
Maine	4	1	5
Nebraska	3	2	5
New Hampshire	3	2	5
Oklahoma	1	2	3
Wyoming	2	1	3
Delaware	2	0	2
Kentucky	2	0	2
Nevada	1	1	2
South Dakota	2	0	2
New Mexico	0	1	1
North Dakota	0	1	1
Vermont	1	0	1
Rhode Island	0	0	0
Canada	20	14	34

Merely giving the number of members of our Association in each state probably does not indicate the entomological interest in the various states as satisfactorily as a comparison of our membership with the total population. This method, used by the American Association for the Advancement of Science, was tried with interesting results. Leaving out the District of Columbia with 133 members per million population, Arizona, Nevada, and California take the lead with 30, 26, and 25 per million; Florida is in fourth place with 23 per million; and then follow Mississippi, Utah, Oregon, Idaho, and Wyoming with 20, 18, 17, 16, and 15 per million. The first Eastern State is Massachusetts in tenth place with 15 members per million population. The other states are as follows:

Louisiana	13	South Carolina	6	Georgia	4
Montana	13	New York	6	Missouri	4
Kansas	11	Tennessee	6	Illinois	4
New Hampshire	11	Minnesota	5	Michigan	4
Connecticut	11	Wisconsin	5	South Dakota	3
Colorado	11	Texas	5	Vermont	3
New Jersey	10	Maryland	5	New Mexico	3
Delaware	9	West Virginia	5	Alabama	2
Washington	7	North Carolina	4	North Dakota	2
Ohio	7	Pennsylvania	4	Oklahoma	1
Virginia	7	Indiana	4	Kentucky	1
Maine	7	Arkansas	4	Rhode Island	0
Iowa	6	Nebraska	4		

Since very few of our colored friends have displayed much interest in entomology, and practically all of our members are white, it seemed that it might be proper to determine the entomological interest in the various states by comparing our members to the total white population. When that was done, to my pleasant surprise, I found that next to the District of Columbia with 177 members per million of white population, my own state of Mississippi is leading with 42 members in this Association to each million of white population. Florida is second with 34. Then follow Arizona, Nevada, and California with 34, 28, and 27 per million. Louisiana with 22 is in sixth place, followed by Utah, Oregon, Idaho, and Wyoming. Massachusetts in eleventh place is once more the leading state from the Northern and Eastern part of the country. According to number of members per million of white population, the states rank as follows:

District of Columbia	177	Colorado	11	Minnesota	5
Mississippi	42	Delaware	10	Wisconsin	5
Florida	34	Virginia	10	Pennsylvania	4
Arizona	34	New Jersey	10	Indiana	4
Nevada	28	Washington	8	Missouri	4
California	27	Ohio	7	Nebraska	4
Louisiana	22	Tennessee	7	Illinois	4
Utah	18	Maine	7	Michigan	4
Oregon	17	Georgia	7	Alabama	3
Idaho	16	Iowa	6	South Dakota	3
Wyoming	16	North Carolina	6	New Mexico	3
Massachusetts	15	Texas	6	Vermont	3
Montana	13	New York	6	Oklahoma	2
South Carolina	12	Maryland	6	North Dakota	2
Kansas	12	Arkansas	5	Kentucky	1
New Hampshire	11	West Virginia	5	Rhode Island	0
Connecticut	11				

As the objection might be raised that a study of the distribution of the economic emtomologists does not give a true index of the interest in entomology in the various states, lists were prepared by states of all persons who are members of this Association, the Entomological Society of America, or of both organizations. This does not greatly change the results, but is somewhat more favorable to the Eastern and Northern States. Our sister society is stronger in those states than is this Association. Considering the total number of persons who are members of one or both Associations, New York leads with 114 and California drops to second place with 108, but in proportion to total population California is far ahead. The distribution by states of the persons who are members of the American Association of Economic Entomologists or the Entomological Society of America, or of both of these organizations, is as follows:

New York	114	Virginia	20	Nebraska	8
California	108	Connecticut	19	West Virginia	8
Massachusetts	97	Minnesota	19	Idaho	7
District of Columbia	66	Tennessee	15	Maine	7
Pennsylvania	63	Wisconsin	15	New Hampshire	7
Ohio	58	Maryland	14	Alabama	6
Mississippi	38	North Carolina	14	North Dakota	6
Illinois	37	Georgia	13	Oklahoma	5
New Jersey	35	Oregon	13	Delaware	4
Florida	33	Washington	13	Kentucky	4
Kansas	31	Utah	12	Nevada	3
Louisiana	26	Colorado	12	Rhode Island	3
Texas	24	South Carolina	11	Wyoming	3
Iowa	23	Arizona	10	New Mexico	2
Indiana	21	Montana	9	South Dakota	2
Missouri	21	Arkansas	8	Vermont	1
Michigan	20				

A study of the distribution of our members now as compared with previous years is favorable to the Southern and Western States. It indicates that our membership has in recent years been increasing more rapidly in these regions than in the Northern and Eastern States. At the first annual meeting of this Association in 1889, twenty were in attendance with one member, or 5%, from the Southern States. For the next fifteen years the Southern States averaged less than 10% of the members. There has been a gradual increase since 1904 until now this region furnishes approximately 20% of the members.

Bacon is quoted as saying: "Every man is a debtor to his profession." Certainly it is the duty of every entomologist to become a member of the entomological societies to which he is eligible. We have two great sister societies, the Entomological Society of America, and the American Association of Economic Entomologists, working in the closest harmony. Three hundred and eighty-eight of us are members of both organizations. Both of them are rendering real service. They should continue to grow and rank high among the scientific societies of America. The value or importance of a scientific society cannot be judged by the number of members, but members are absolutely essential and organizations of this kind should make a healthy growth from year to year. In every state there are undoubtedly persons who have not joined these societies who are eligible for membership. They would be benefited by membership. Frequently an invitation or suggestion is all that is necessary. Is it not our duty to our friends, as well as to our profession, to encourage them to affiliate with us? The time that I have taken to discuss the distribution of our membership will not have been wasted if it encourages our members in the Southern States, as well as in other regions, to do more towards increasing the membership of our societies.

In the early days conditions were not favorable for the development of entomologists in the Southern States. The country was thinly settled, and there were few colleges and universities. Most of the young men who went to college were from wealthy families. They usually attended some of the eastern colleges, and returned to manage plantations, or to practice law or medicine. There were a few who were greatly interested in insect life from one angle or another, but practically none who could be called entomologists. The few who might have developed into entomologists were isolated. They knew no others who had similar interests. They had no library facilities. They had no contact with entomologists or entomological works in Europe or in other sections of this country. The opportunities for the development of a Harris or a Say or a Fitch were not good and none appeared.

After the Civil War conditions were less favorable. The states and the people were bankrupt. The war had levied a terrible toll and the reconstruction period was a nightmare. Thousands of the most progressive young people moved to other states where they and their children have played an important part in the development of those states. Except the work of numerous pioneers including Smith and Abbott about 1790, and Thomas Say about 1820, and the notable contributions of Glover, Riley, Comstock, Howard, Marlatt, Schwarz, Hubbard, Ashmead, and other federal workers, comparatively little real entomological work was done in the South until sometime after the establishment of the agricultural experiment stations. Even to the present time most of the entomologists in the South have come from Northern States, or have obtained their training in Northern colleges and universities.

Through their students the South is under great obligations to Comstock, Fernald, Osborn, Forbes, Bruner, and others who have played such an important part in the development of entomology in this country, not only by their own researches, but also by the students they have sent out to blaze entomological trails in other states.

Although most of our entomologists of note have received their college training in Northern States, there are a few exceptions. The fact that Dr. A. L. Quaintance is the product of Florida and Alabama colleges shows that able entomologists may be produced in this region.

COTTON STATES ENTOMOLOGISTS. Although the group known as the Cotton States Entomologists has been formally recognized as a branch of this Association for only two years, it has in reality been in existence for more than 23 years. Meeting at irregular intervals this group of entomologists in the Southern States has had an organization and has held many meetings, some of them devoted chiefly to one or two topics, while others have had more varied programs. This rather informal organization was probably the first association of its kind in this country, that is, an association of economic entomologists representing a large group of states, geographically located so that they have many entomological problems in common. This association covered the field now represented by the Cotton States Branch of the American Association of Economic Entomologists, and by the Southern Plant Board. Both of them are direct outgrowths from it.

In Entomological News for November, 1904, appears a report of the first meeting of the Official Entomologists of the Cotton Belt held in Jackson, Mississippi, on August 2, 1904, to discuss matters relating to state quarantines.

The officers elected were: C. E. Chambliss, Clemson College, South Carolina, Chairman; A. W. Morrill, then with the United States Bureau of Entomology, Secretary; and as additional members of the Executive Committee, H. A. Morgan, then in charge of the entomological work in Louisiana, and Glenn W. Herrick, who held a similar position in Mississippi. Others in attendance at this first meeting were Wilmon Newell of Georgia, E. D. Sanderson of Texas, W. V. Reed of Mississippi, and W. D. Hunter of the United States Bureau of Entomology.

This meeting held at Jackson, Mississippi, on August 2, 1904, is of special historical significance as probably the very beginning of the

the regional branches of this Association and also of the regional Plant Boards.

The second meeting of the Association of Official Entomologists of the Cotton Belt was held at Atlanta, Georgia, on May 6, 1905. A report of this meeting by A. W. Morrill, Secretary, appears in Entomological News for September, 1905. Among the dozen or more in attendance were Wilmon Newell, Glenn W. Herrick, H. A. Morgan, G. M. Bentley, W. D. Hunter, and A. W. Morrill. Since then meetings have been held at Memphis, Houston, Vicksburg, Tallulah, New Orleans, Birmingham, Gainesville, Atlanta, and probably other places. Often more than 50 entomological workers have been in attendance. On several occasions there was so much interest in certain topics under discussion that 100 and even 150 people have attended.

ENTOMOLOGICAL ACTIVITIES AT THE PRESENT TIME

In order to present in definite form just what the Southern States are doing in various phases of entomology, I have made a compilation regarding the activities of the eleven states in this region in entomological research, the teaching of entomology, extension work in entomology, regulatory work (including nursery inspection, apiary inspection, enforcement of quarantines, etc.), and insect collections.

ENTOMOLOGICAL RESEARCH. Although the amount of money spent and the number of workers employed may not indicate the real standing of an institution or a state so far as productive research is concerned, they do at least in a degree indicate the extent that the entomologists and their problems are appreciated.

The eleven states listed according to the amount of money that their Experiment Stations are annually spending on entomological research are as follows:

STATE	AMOUNT SPENT ON RESEARCH	NUMBER OF RESEARCH WORKERS
Texas	$20,900.00	13 full and part time
Florida	18,351.00	6
Louisiana	15,000.00	4 and part time assistants
North Carolina	9,500.00	5 part time
Arkansas	9,200.00	3
South Carolina	9,000.00	3 full and 1 part time
Alabama	8,900.00	4 part time
Mississippi	6,500.00	1 full and 2 part time
Tennessee	6,000.00	2
Oklahoma	2,000.00	3 part time
Georgia	500.00	4 part time

(The Georgia Experiment Station has no entomology department, but some insect studies are carried on by other departments.)

These figures total $105,851.00 that is now being spent annually by the eleven Southern Experiment Stations for entomological investigations. This gives an average of $9,623.00 for each station. These fifty people in eleven states devoting part or all of their time to entomological research are working on 79 different projects. An idea of the nature of their work may be obtained by listing the projects in each state.

Alabama with 4 part time workers spending $8,900.00 has nine projects as follows:

1. Life history and control of the belted bean beetle, *Diabrotica balteata* Le Conte.
2. Ecology and control of the cotton aphis.
3. Dusting cotton for cotton boll weevil control.
4. Life history and control of the oriental fruit moth, *Laspeyresia molesta* Busck.
5. Life history, ecology, and control of the pecan weevil, *Balaninus caryae* Horn.
6. The strawberry root louse.
7. Life history and control of the turnip webworm, *Hellula undalis* Fabricius.
8. Life history and control of the pickle worm and canteloupe caterpillar.
9. Boll weevil hibernation.

Arkansas with 3 workers spending $9,200.00 has nine projects as follows:

1. Poisonous Arthropods.
2. Biology of the southern corn rootworm.
3. The ecology of cotton insects.
4. Orchard insects.
5. Shade tree insects.
6. The strawberry weevil.
7. Insect pest survey.
8. Life histories of *Tabanidae*.
9. The biology of the rice water weevil.

Florida with 6 workers spending $18,351.00 has eleven projects as follows:

1. Studies of the bean jassid, *Empoasca mali* Le Baron.
2. The Florida flower thrips on citrus, peanuts, beans, eggplants, and forage crops.
3. Nativity, life history, host plants, and control of the green citrus aphid (*Aphis pomi*, De Geer).
4. The larger plant bugs on citrus, pecan, and truck crops.
5. Control of cotton insects—the boll weevil.
6. Introduction of beneficial insects, including the California white-fly eating lady beetle, *Delphastus*, the Sicilian mealybug parasite, *Paraleptomastis*, the European mealy bug-eating lady beetle, *Scymnus*, parasites of the cane borer, and other promising parasites.
7. Insects affecting pecan trees.
8. Field study of the insects attacking the pecan, including control measures.

9. Life history studies of the velvet bean caterpillar, *Anticarsia gemmatilis* Hübner.
10. Insect pests and plant diseases and their control.
11. Life history studies of *Pycnoscelus surinamensis* L., the roach which is the intermediate host of Manson's eye worm.

Georgia with no entomological workers has four people in other departments spending $500.00 for two projects as follows:

1. A study of boll weevil hibernation under Georgia conditions.
2. Methods of controlling the boll weevil.

Louisiana with four workers and some part time assistants is spending $15,000 on five projects as follows:

1. Insects affecting rice and soy beans.
2. Sugar cane moth borer control.
3. Mexican cotton boll weevil, hibernation and control.
4. Cattle parasites.
5. Truck crop insect control.

Mississippi with one full time and two part time workers is spending $6,500 on three projects as follows:

1. Pecan insects—biological and economic study.
2. Scale insects—systematic, biological, and ecological study.
3. Cotton aphis.

North Carolina with four part time workers is spending $9,500.00 on seven projects as follows:

1. Mexican bean beetle, *Epilachna corrupta* Mulsant,—spread, life history, habits, food preferences, natural enemies, and control.
2. Wintering bees—to determine the best method of wintering bees under North Carolina conditions.
3. A survey of the honey producing plants of the state.
4. The corn earworm—a study of varietal resistance to this insect.
5. A study of the corn rootworm—to determine the efficiency of rotation and repellents in the control of this insect.
6. Biology of the Homoptera (leafhoppers).
7. The tobacco flea beetle—to study types of trap beds most efficient in their control.

Oklahoma with three part time workers is spending $2,000.00 on five projects as follows:

1. The corn leaf louse.
2. The cowpea aphis.
3. Boll weevil investigations.
4. Effect of insecticides on birds.
5. Insect and Plant Pest Survey of Oklahoma.

South Carolina with three full time and one part time worker is spending $9,000.00 on ten projects as follows:

1. Biology and control of the Mexican bean beetle.
2. Investigation of the ecology and control of the corn bill bug.
3. Biology and control of the corn weevil.
4. A study of the influence of different factors on the hibernation of the boll weevil.
5. Field tests with various makes and kinds of machines for applying poison to cotton.
6. The toxicity of insecticides.
7. Biology and control of the cotton flea hopper.
8. Biology and control of certain deciduous fruit insects.
9. Biology and control of the persimmon psylla.
10. Biology and control of the tomato fruit worm.

Tennessee with two workers is spending $6,000.00 on three projects as follows:

1. Ecology and control of cutworms.
2. The woolly aphis.
3. The fluorine compounds as insecticides.

Texas with thirteen full and part time workers is spending $20,900 on 13 projects as follows:

1. Ingestion of poison by boll weevil.
2. Airplane dusting.
3. Cotton flea hopper investigations.
4. Hibernation of cotton flea hopper and boll weevil.
5. Control of ants attacking citrus.
6. Control of scale insects on citrus.
7. Control of plant lice on truck crops in coastal plain.
8. Sulphur as an insecticide.
9. Control of insects in corn, and grain sorghum while in storage.
10. Pecan nut case-bearer.
11. Pecan twig girdler.
12. Beekeeping investigations.
13. Foulbrood inspection.

Besides the work of the Experiment Stations, entomologists connected with other institutions are carrying on investigations of importance. This is true of many teachers. It is also true of entomologists connected with organizations that are primarily regulatory in their function, notably the work of Dr. Leiby and his assistants in the State Department of Agriculture in North Carolina, and Dr. Berger, Dr. Ball, and their assistants in the State Plant Board of Florida. The State Board of Entomology in Georgia is also spending at least $15,000 per year on investigations in entomology and plant pathology.

Although I do not have the exact figures, the United States Bureau of Entomology is spending considerably more in the Southern States on entomological research than are the states themselves. Probably the most important and extensive investigations, because of the importance of the crop, are the studies of the boll weevil and other cotton insects that are being made by Coad and his associates in Louisiana, Texas, and South Carolina. Other research activities of great value now being conducted by the Bureau of Entomology in the Southern States are the studies of insects that affect livestock by Bishopp and his associates in Texas, the malaria mosquito investigations of King and his associates in Louisiana, the citrus insect work of Yothers in Florida, the peach insect studies of Snapp and his associates in Georgia, the sugar cane and rice insect investigations of Holloway and his associates in Louisiana, and the tobacco insect investigations of A. C. Morgan and his associates in Tennessee and Florida.

Other Bureau of Entomology workers are doing notable work in investigating apple insects in Arkansas, pecan insects in Georgia, and Texas, various cereal and forage crop insects in Tennessee and Texas, various truck crop insects in Alabama, Florida, Louisiana, Mississippi, and North Carolina, and the camphor scale in Louisiana.

About a year ago I made a list of the scientific workers employed on a permanent basis by the Bureau of Entomology to investigate insect problems in the Cotton States. There were 73 names on this list. Oklahoma was the only state in which there were no research workers connected with the Bureau of Entomology. In the other ten states there were 73 full time workers studying insect problems as compared to about 50 workers employed by the states, many of them on a part time basis.

The Bureau of Entomology projects that are located partly or entireiy in the Southern States and the funds assigned to each are as follows:

Peach insects	$22,400	(part)
Nut insects	23,445	(part)
Citrus insects	14,085	
Camphor scale	13,000	
Sweet potato weevil	40,535	
Tobacco insects	26,510	
Mexican bean beetle	32,500	(part)
Sugar cane and rice insects	14,775	
Cotton insects	256,055	
Insects affecting forest trees	28,090	(part)
Insects affecting man	12,880	(part)
Insects affecting cattle	27,300	(part)
Stored grain insects	19,460	(part)
Mexican fruit worm	30,763	

For the fiscal year 1928, the Federal Horticultural Board has an appropriation of $242,800 for pink bollworm work.

TEACHING ENTOMOLOGY. In ten of the eleven Agricultural Colleges in the Cotton States there are entomological departments doing splendid work. The personality, enthusiasm, and ability of the teachers determine chiefly the strength of the various departments. These qualities do not lend themselves easily to tabulation.

The number of people teaching entomology, the number of courses offered, the number of students enrolled, and the approximate amount of money spent annually for teaching entomology (including beekeeping) in the Southern Agricultural Colleges are as follows:

STATE	NUMBER OF PART TIME AND FULL TIME TEACHERS	APPROXIMATE NUMBER OF COURSES IN ENTOMOLOGY	NUMBER OF STUDENTS ENROLLED	APPROXIMATE FUNDS SPENT IN TEACHING ENTOMOLOGY
Alabama	4	4	160	$3,000.00
Arkansas	2	5	64	1,500.00
Florida	5	6	56	11,000.00[1]
Georgia	1	1	6	———[2]
Louisiana	3	9	112	6,000.00
Mississippi	3	6	158	9,500.00[3]
North Carolina	3	7	83	8,250.00[3]
Oklahoma	2	5	113	3,400.00
South Carolina	3	8	72	4,800.00
Tennessee	4	7	131	4,725.00
Texas	3	4	163	11,750.00
Totals	33	62	1118	$63,925.00

[1] This amount is an estimate made by the author. It includes expenditures for the entomology department of the Agricultural College, as well as part of the expenditures of the Department of Biology of the University of Florida where several courses in entomology are offered.

[2] There is no department of entomology in the Georgia Agricultural College. The horticultural department offers one course in entomology.

[3] In Mississippi and North Carolina the funds indicated include expenditures for both zoology and entomology.

Entomology is also taught in quite a number of other colleges and universities. Normal Colleges, Junior Colleges, and Agricultural High Schools are also offering courses in entomology. To a large extent the teachers in these institutions have received their entomological training in the Southern Agricultural Colleges—while the teachers in the colleges have in turn to a large extent received their training in such institutions as Cornell University, Ohio State University, Massachusetts Agricultural College, the Universities of Minnesota, Kansas, Michigan, Illinois, and Iowa.

EXTENSION ENTOMOLOGY. Every entomologist probably does more or less extension work. Many cannot avoid it. The title of Extension Entomologist is, however, comparatively recent, as the Extension Departments as separate organizations are themselves in most cases less than 20 years of age. Six of the Cotton States now have 10 full time extension entomologists. This is a field that will undoubtedly develop rapidly during the next few years. The states with extension entomologists are as follows:

STATE	NUMBER OF EXTENSION ENTOMOLOGISTS	EXPENDITURES FOR EXTENSION ENTOMOLOGY
North Carolina	3	$8,260.00
Louisiana	2	7,500.00
South Carolina	2	6,650.00
Texas	1	5,100.00
Alabama	1	4,200.00
Oklahoma	1	3,100.00
Total	10	$34,810.00

INSECT COLLECTIONS. In no phase of entomological endeavor are the Cotton States probably so far behind other sections of North America as in the matter of insect collections. Although people have been collecting insects in these states for more than a century, there are still very few collections of importance. Much of the collecting done in the South has been by people from other regions who have taken their insects with them. Many of the insects collected by Southern workers have also found their way into collections outside of this region. Some of the more important collections in each of the eleven Cotton States will be mentioned:

ALABAMA. H. P. Loding of Mobile has about 60,000 specimens of Coleoptera from the United States representing about 10,000 species and varieties. He has sent many thousands of specimens to friends, correspondents, and museums. He has 2,500 species of Coleoptera from Alabama, collected almost entirely by himself and his fellow collector, T. S. Van Aller. Over 2,000 species were collected in Mobile County. This collection appears all the more remarkable when it is considered that the Rhynchophora and several important families, such as *Staphylinidae*, *Scydmaenidae*, and *Pselaphidae*, have scarcely been touched. From their collecting in Mobile County 52 new species and 11 varieties of Coleoptera have been described, including several new genera, and at least one introduced genus has been added to the fauna of North America.

In Mobile there is also a collection of several thousand specimens of North American Lepidoptera made by W. C. Dukes assisted by T. S. Van Aller. The genus

Catocala is nearly complete in North American forms. The *Sphingidae*, *Sesiidae*, and *Hesperidae* are well represented. This is an excellent collection of the Gulf Coast fauna.

The collection of the Alabama Polytechnic Institute was largely destroyed by fire in 1920. At present it contains approximately 10,000 specimens, representing about 3,000 species, largely Coleoptera.

In the Alabama Museum of Natural History at the University of Alabama there are some undetermined insect collections made by the late Herbert H. Smith.

ARKANSAS. At the University of Arkansas the collection consists of approximately 30,000 specimens representing about 3,500 species, including 28 types. This collection consists largely of Diptera and Coleoptera. The Diptera collection was brought together by C. F. Adams and is known as the Adams Collection.

FLORIDA. At the University of Florida at Gainesville there are several collections. The State Plant Board has about 10,000 specimens representing almost exactly 1,000 species including 10 types. This collection consists largely of *Coccidae*, *Aleurodidae*, and Coleoptera, and the records are filed by locality, by species, by host, and consecutively by number.

The Experiment Station has about 25,000 specimens, representing about 3,500 species, including 25 types. Thysanoptera, Coleoptera, and Aphididae predominate.

The Entomology Department of the College of Agriculture has between 7,000 and 10,000 specimens from which about 1,000 species have been identified, including 150 types. This collection consists chiefly of Coleoptera, Orthoptera and Lepidoptera.

In the Department of Biology of the University of Florida there are over 5000 specimens, about two-thirds of which have been identified by specialists, besides three personal collections. Professor J. Speed Rogers has about 65,000 specimens of Tipulidae and closely related families representing between 600 and 900 species, and including 35 holotypes, 20 allotypes, and about 250 paratypes. These flies are from many parts of the world, two-thirds of them with exact habitat data, and all with exact locality and date records. He has an alcoholic collection of about 1000 immature forms, including 110 known or reared species representing 45 genera. Professor T. H. Hubbell has about 30,000 specimens of Orthoptera, and Professor C. F. Byers has a collection of adults and nymphs of Odonata.

GEORGIA. The State Board of Entomology has a collection of insects at the State Capitol in Atlanta.

LOUISIANA. At Baton Rouge there are several collections. The old Louisiana Crop Pest Commission collection is in the State Department of Agriculture. The Experiment Station has 10,000 or 12,000 specimens, largely Coleoptera, and Diptera, with Tabanidae especially well represented. The Louisiana State University has a collection of approximately 2,000 species, largely Coleoptera and Hemiptera. Mr. C. E. Smith of the United States Bureau of Entomology is reported as having a personal collection. At the State Museum in New Orleans there is a collection of insects, including the Odonata of Louisiana made by Edward Foster and the late J. C. Smith from 1897 to 1900. Tulane University and some other colleges in Louisiana also have insect collections.

MISSISSIPPI. The combined collection of the A. & M. College, Agricultural Experiment Station, and State Plant Board contains approximately 75,000 specimens; about 3,000 species have been identified.

NORTH CAROLINA. Probably the best state collection of insects in the South is at the State Department of Agriculture in Raleigh, consisting of about 75,000 specimens, representing 6,000 species of North Carolina insects, with records of 7,725 species from that state. At the State College the collection consists of about 30,000 specimens representing approximately 5,000 species with Homoptera well represented, including about 50 types.

OKLAHOMA. The A. & M. College at Stillwater has about 2,000 specimens and about 500 species with Scarabaeidae well represented.

SOUTH CAROLINA. At Clemson College under the leadership of Franklin Sherman a start has been made during the past two years on a state collection with a card catalogue system similar to that in use in North Carolina. The collection now consists of about 20,000 specimens of which about 800, mostly Coleoptera, have been identified.

TENNESSEE. At the University of Tennessee there is a general collection of insects arranged in 178 Schmitt and 60 Comstock boxes.

TEXAS. At College Station there are two collections. The Experiment Station has between 5,000 and 7,000 specimens of which only about 300 species have been identified. The college has approximately 12,000 specimens representing about 2,600 species, mostly Acrididae, Miridae, Cerambycidae, and Curculionidae.

REGULATORY WORK. Comparatively the regulatory work in the Southern States is probably given better support than any other phase of entomological activity. The support for regulatory work covers both insects and plant diseases, and includes nursery inspection, apiary inspection, enforcement of quarantines, and eradication and control campaigns against various insects and diseases. This work is handled by organizations bearing various names, as State Board of Entomology, State Department of Agriculture, State Crop Pest Commission, and State Plant Board. Much of the entomological work done by these organizations might properly be classed as extension work. In each of these organizations there are individuals who are doing research work. In some cases this is necessary because of the demand for, or urgent need of investigations. In other cases it is done because of the inherent desire to explore new fields and to add to our store of knowledge.

As in other activities the efficiency or the value of this work cannot be gauged by the size of the appropriation devoted to it. However, the amount of money allowed for this purpose indicates its importance in the minds of the public. The annual financial support given, and the number of workers employed in regulatory work in the eleven Cotton States are as follows:

STATE	ANNUAL FINANCIAL SUPPORT	NUMBER OF WORKERS
Florida	$262,408.00	87
Mississippi	97,500.00	39
Georgia	70,000.00	20
Tennessee	67,700.00	14
Texas	59,140.00	19
Louisiana	37,500.00	13
North Carolina	24,000.00	6
Alabama	23,000.00	10
Arkansas	22,000.00	7
South Carolina	10,000.00	4
Oklahoma	4,000.00	1
11 States	$677,248.00	210

These eleven states have 210 workers engaged in regulatory work and are spending annually $677,248.00. The average appropriation for regulatory work in these eleven states is $61,568.00, and the average number of workers is 19. However, the amount of regulatory work that is attempted and the thoroughness with which this is done varies greatly in the different states. Florida employs 87 workers and spends $262,408.00 while Oklahoma spends only $4,000.00 and employs one person to handle all of their inspection and regulatory activities.

The Federal Horticultural Board is also extensively engaged in regulatory work in the Southern States. To enforce the foreign plant quarantines there are at least 30 inspectors located at ports of entry in Texas, Louisiana, and South Carolina. There are also in Texas 50 inspectors to enforce the quarantines against the pink bollworm and Thurberia weevil.

INSECTS AND SOUTHERN PROGRESS

It is doubtful if anywhere else on the North American continent insects have so vitally affected the social, economic, and industrial affairs of millions of people as they have in the Southern States.

It is impossible to estimate the part that the Anopheles mosquitoes, the cattle tick, and the boll weevil, have played in retarding the development of what is to be one of the richest and most progressive agricultural regions of the world. It is certain that they have played a leading part. Any financial estimate of the loss they have caused would have to be reckoned in billions of dollars, and even greater are the losses that cannot be estimated.

ANOPHELES MOSQUITOES. How many thousands of people have filled early graves because their lives were shortened ten or twenty, or even thirty or forty years, because of the Anopheles mosquitoes? Who can estimate what might have been accomplished by hundreds of thousands of people whose entire lives were blighted and weakened because of the presence of Anopheles mosquitoes? Who can estimate what might have been accomplished by the many thousands of people who would have migrated to this section of the country if it had not been for these mosquitoes.

Twenty years ago at the Mississippi Agricultural and Mechanical College for a month or more after college opened each fall the hospital would be crowded with students from the Delta Section of the State who were suffering from malaria. Dozens of the worst cases would be kept in the hospital, and in addition the college physician would usually be called upon to treat several hundred milder cases. What are the conditions now? For several years the college physician has not had to treat a single serious case of malaria, and only a small number of mild cases which scarcely interfere with the students' work.

The Anopheles mosquitoes and malaria are being reduced from year to year. Where a generation ago they went unchecked, a new agricultural empire is developing in a region with soil as fertile as any on this continent, and where health conditions are now above the average and are improving constantly. Sunflower County, Mississippi, in the center of the Yazoo-Mississippi Delta, was twenty years ago teeming with mosquitoes and malaria, yet in 1923 and 1924 girls from this county won the National Health Contest in Chicago in competition with the healthiest girls from all parts of the country, and the 1926 girl from that county tied for first place with an Iowa girl. Could this have happened twenty years ago? Who can estimate the part in this mosquito and malaria control that has been played by Howard, by Herrick, by Van Dine, by King, and other entomologists of vision who have been interested in this problem?

The important role that Dr. Howard has played in this great fight against malaria is well known to every entomologist. The fact that for years he has been honorary president of the national association interested in the control and eradication of malaria, an organization composed chiefly of medical men and containing few if any entomologists, indicates that his services in this fight against malaria are recognized and appreciated by those outside of our profession who are now most interested in this subject.

THE CATTLE TICK. No one can ever estimate with any degree of accuracy what the cattle tick has directly and indirectly cost the

Southern States. All estimates place the annual loss at many millions of dollars. This does not take into consideration the great losses caused by undernourishment of millions of children because of the lack of milk and butter, due to the presence of the cattle tick. The eradication of this pest is based upon our knowledge of its life history and habits. This was an entomological problem, and numerous entomologists have played important parts in its solution, although the actual task of eradicating the tick has to a large extent been passed on to others.

Eradicating the cattle tick has in many ways benefited thousands of farmers who formerly depended upon cotton for their money crop, but who are now receiving a large part of their income from cattle raising and dairying. The effect has been remarkable. In Mississippi, in 1912, the dairy industry amounted to practically nothing. In that year the first creamery was established. Today there are 27 creameries in the state. Less than two years ago the first condensery was opened. Now there are four in the state, and plans are being made for others. A year ago there was not a cheese factory in Mississippi. Now there are five and others are being built. There are sixty-five ice cream factories in the state, all established during recent years. These manufacturing establishments, dependent upon the eradication of the cattle tick, have been successful beyond the expectations of those who estabished them. Many of them are enlarging as the supply of milk has increased beyond their capacity to handle it.

In 1912, the average annual production per cow in Mississippi was 1320 pounds of milk. In 1925, due largely to the eradication of the cattle tick from large areas, the average production of the state was 2200 pounds per year, an increase of 880 pounds per cow. In 1912, the butter manufactured in Mississippi amounted to one-half ounce per minute, valued at less than one cent. In 1926, the production had increased to 14 pounds per minute, valued at $6.50.

THE BOLL WEEVIL. Only those who experienced it can realize the devastation and economic depression caused by the boll weevil as it first spread across the Gulf States. It caused hundreds of thousands of people to move from their farms to nearby towns and to other states and other regions. It forced thousands upon thousands to seek other occupations. Scores of banks closed their doors because of this one insect. Land values fell, not only to 50%, but frequently dropped to one-third, one-fourth, or even one-fifth of their former value. Families who had lived proudly on the same plantations for generations lost their lands and homes, and in thousands of cases were left practically penniless. Mercantile establishments that had flourished for 40 or

50 years were bankrupt by the dozen. The business of the entire nation felt the effects of this insect, as it first spread across Texas, Louisiana, and Mississippi, and only in a less degree did these things happen in Alabama and Georgia. By the time it reached the Carolinas the entomologists and others had so thoroughly prepared the farmers for the advent of the boll weevil that its appearance was not followed by such disastrous results.

ENTOMOLOGICAL ACHIEVEMENTS

It would seem fitting that a few of the more important entomological accomplishments in the South should be mentioned. Many worthy of consideration might be listed. Time will permit a brief mention of only twelve.

1. The Eradication of the Cattle Tick is probably the largest eradication campaign that has ever been undertaken. It was the first effort to completely eradicate an Arthropod from a large area.

Tick eradication was undertaken on a country-wide basis on July 1, 1906, when the first Federal appropriation for the work became available. About that time all of the infested states except Florida began the work. This included the Cotton States and a few counties in the southern parts of Virginia, Kentucky, Missouri, and California. By December 1, 1927, 750 of the 985 counties had been released from quarantine, and 653 were entirely tick free.

In passing it might be mentioned that the epoch-making investigations of Smith and Kilborne, the first experimental proof that diseases may be transmitted from one host animal to another by an Arthropod as an intermediate host, were largely carried on in North Carolina.

2. The eradication of the Pink Bollworm from five parishes in Louisiana and from eleven counties in eastern Texas was a project of large size and great importance conceived and carried through successfully by entomologists.

3. The eradication of citrus canker is not an entomological project, but entomologists deserve a large amount of credit for what has been accomplished. It was first discovered in Florida by an entomologist, Berger, in 1912. While some plant pathologists at least were calling it a form of citrus scab, he recognized it as a new and very serious disease. The first eradication campaign against citrus canker was started in May, 1914 by Berger and others in Dade County, Florida. Later, while some plant pathologists were skeptical about even attempting to eradicate the disease, another entomologist, Newell, perfected an organization and worked out a plan for the complete eradication

of the disease from Florida. Entomologists in other states following the Florida methods have also been remarkably successful in apparently eradicating this bacterial disease of citrus plants.

4. The use of cultural practices to control an important insect pest was first recommended and used in the South against the boll weevil. It is, of course, possible that cultural practices were used to control insects at an earlier period in some other region, but apparently they were not in use against any major crop pest before Townsend, Howard, and Mally made their early invetsigations of the boll weevil and recommended cultural control practices.

5. The use of calcium arsenate as an insecticide on a large scale is undoubtedly due to the efforts of Coad. Before his experiments indicated the great value of this material against the boll weevil, very little calcium arsenate was manufactured, and it was scarcely of any value at all as an insecticide. Through his persistence this material is now manufactured by thousands of tons and almost anywhere calcium arsenate of good quality may be purchased.

6. Arsenate of lead in the form of a dust is now in use at many places against many insects. Before Newell, while still in Louisiana, had persuaded a chemical manufacturer to prepare this material as a dust or powder it had been manufactured only in the paste form. His discovery of its value as a powder was a notable advance in economic entomology.

7. The extensive boll weevil studies made by Howard, Townsend, Mally, Hunter, Sanderson, Newell, Hinds, Pierce, Coad, and their associates, and others will compare favorably with the studies made on any insect.

8. The use of the airplane as an important entomological adjunct, started by Houser in Ohio, seems to have found its greatest usefulness and development in the South. Coad and his associates deserve much credit for what has been accomplished in making the airplane of great value in entomological work. The use of the airplane for insect control is increasing rapidly. It is now used far more extensively than most of us realize.

9. The extensive studies of the Argentine Ant by Newell and his associates in Louisiana and by E. R. Barber while with the United States Bureau of Entomology resulted in the development of the poison syrup for use against this insect. This poison syrup as demonstrated extensively by Barber is one of the *most* efficient controls ever devised for a major pest.

10. The development of oil emulsions as insecticides has to a large extent been based on work done in the Southern States, especially in Florida from the discovery of kerosene emulsion by Hubbard nearly fifty years ago to the perfection during recent years by Yothers of formulas for preparing lubricating oil emulsions that can be made by anybody at slight cost and in any quantity. This recent work by Yothers has done much to revolutionize dormant spray schedules throughout the United States.

11. The organization for enforcing quarantines and doing other regulatory work of the Florida State Plant Board has set a standard of efficiency and service which any state might well strive to attain.

12. The experiments with fluosilicates by Marcovitch in Tennessee are responsible for the widespread interest in these and related chemicals as insecticides.

Anyone acquainted with entomological work in the Southern States can prepare other lists of entomological achievements that will compare favorably with the twelve just mentioned.

Public Confidence

Throughout the Southern States many of the entomologists have, it seems, to a remarkable degree won and held the confidence of the citizenship of the various states, and also of their colleagues in other lines of agricultural endeavor. To indicate what I have in mind it may be desirable to refer to just three cases. Here in Tennessee, the president of the State University is one of our own members, who twenty years ago today was president of this Association. We all know of the work of H. A. Morgan as an entomologist in Louisiana and later in Tennessee. After years of service, it was not mere accident that he was selected as Director of the Tennessee Experiment Station, Dean of the College of Agriculture, and later President of the University. It is an interesting coincidence that almost exactly twenty years after giving his presidential address to this Association at its twentieth annual meeting in Chicago, he returned to that city during the past month to deliver the presidential address and to preside over the Association of Land Grant Colleges and Universities.

Dr. W. D. Hunter, another entomologist who gave most of his life to the South, won the confidence of the people of the Cotton Belt to a degree that few men in any line of work ever attain. It would probably be difficult to find an educated cotton grower who did not appreciate Dr. Hunter's services. I speak advisedly for Mississippi and Louisiana, and I have no doubt the same was true in Arkansas, Texas, and other cotton growing states. His quiet, modest manner, his ability to grasp big problems, his keenness in seeing the essentials of any proposition, and various other qualities, won for him many friends, especially among our most intelligent and progressive citizens. The big bankers, business men, industrial leaders, railroad presidents, governors of states, editors, educators, and farmers went to Dr. Hunter for advice. The many editorials that appeared in daily, weekly, and farm papers throughout the Cotton Belt lamenting his untimely death indicated much more forcibly than I could express the important place he had won in this region.

Dr. Wilmon Newell of Florida has for nearly thirty years been an outstanding leader in entomological matters in the Cotton States. The fact that since 1921, besides being the chief executive officer of the State Plant Board of Florida, Dr. Newell has also been Director of the Agricultural Extension Service, Director of the Agricultural Experiment Station, and Dean of the College of Agriculture, indicates very forcibly, not only his ability, but also the confidence which is placed in him by the citizens of Florida.

In passing I might add one additional note of interest to emphasize the point I am discussing. The Association of Southern Agricultural Workers is a great organization, including the workers in agronomy, animal husbandry, horticulture, and all the other various branches of agriculture in the agricultural colleges, experiment stations, and state departments of the Cotton Belt, besides editors of agricultural papers, and representatives of commercial firms interested in agriculture. At the present time three of the four officers of that Association are entomologists and members of our own Association. I refer to H. A. Morgan of Tennessee, Wilmon Newell of Florida, and W. E. Hinds of Louisiana.

THE AMATEUR ENTOMOLOGIST

A year ago today my predecessor paid fitting tribute to the amateur entomologist. Any discussion of Southern entomology would be incomplete without a reference to him. There are probably a few in every state. We should assist them, encourage them, and appreciate them. They can and will be of great service to us and to our science. They are usually very modest, unasssuming men, who often seem to think that those of us who bear the title of entomologist must know more about insects than they do. As a matter of fact, many of these amateurs are really better informed entomologists than some of us who bear that title.

In Mobile, Alabama, a printer, a druggist, and a florist are busily engaged in their various occupations, but they love entomology, and many of their nights and holidays are devoted to this science. Every student of the Lepidoptera and Coleoptera in North America knows of Dukes, Van Aller, and Loding. Entomologically they have put Mobile "on the map," and have added much to our knowledge of the fauna of the Gulf Coast region.

Less than two weeks ago in Natchez, Mississippi, a cotton planter died whose name is known to few of you. He was born more than seventy years ago in Natchez, and always lived in that community. He never published a line in an entomological journal, but Nature meant him to be an entomologist. If in his youth he had come in contact with an entomologist, it is my opinion that today the name of Andrew Fleming would be known by every entomologist in America. Few men know the insects of any community as he knew them on his own farm and in the city of Natchez.

Dr. Marlatt in his bulletin on the Periodical Cicada mentions that the first person to publish the fact of a 13-year brood of that insect was Dr. D. L. Phares of Woodville, Mississippi on May 17, 1845. In 1889 Dr. Phares collected and sent to Washington the first Colorado potato beetle ever recorded as far South as Mississippi. Dr. Phares did not consider himself an entomologist, but he was a keen observer and a very useful citizen. For forty years before there was an agricultural college in Mississippi, he was recognized throughout the state as an authority on all matters pertaining to agriculture and natural history. The newspapers and periodicals published in Mississippi between 1840 and 1880 contain many articles from his pen. When the Mississippi A. & M. College was established in 1880 he was the first Professor of Biology. Among the subjects that he taught were botany, zoology, entomology, physiology, geology, and veterinary medicine. As an entomologist he must be classed as an amateur, but his service in making careful observations, and in bringing correct information about insects to the public, deserves the commendation of entomologists and the appreciation of his state.

In New Orleans for many years an old newspaper man with an inclination towards entomology has been a real asset to his city, state, and nation. All who are acquainted with the mosquito control campaign in New Orleans from 1900 to 1905 appreciate the important services of Ed Foster in the fight to banish yellow fever from this country. Nearly everyone interested in entomology who has visited New Orleans has had the pleasure of knowing him. He was the first person to recognize the importance of the Argentine ant when it was limited to a small area in New Orleans. In many ways he has served entomology and entomologists.

Entomology in the Southern States is just now passing from what Professor Essig would probably call the Pioneer Period. The Constructive Period has just begun. Much has been accomplished in the past fifty years, but it will appear small indeed compared with what will be accomplished during the next fifty. Fifty years ago there was not a single person in the Southern States employed in entomological work; at most there were very few individuals scattered throughout this region who were really interested in the study of insects. They had little time to devote to it. There were occasional visitors, collectors, or investigators from other sections who were attracted to this region for short periods. *Now* 167 members of this Association are residing in the Southern States, and there are at least as many other people in this region who are devoting a very large part of their time to some phase of entomology. Fifty years ago entomology was not taught anywhere in the South, now there are probably 100 different colleges and schools giving regular courses in entomology.

The young entomologists today are better trained for their life work than were their predecessors thirty or twenty or even ten years ago. The Southern States are calling for them. They are needed. Although in nearly every phase of entomology the Southern States are still behind those regions where entomologists have been working for a longer period and in larger numbers, no section of the country today offers greater opportunities. The student of insect distribution, the collector, the ecologist, the chemist, the physiologist, the taxonomist, and the economic entomologist will find here fertile fields. Many of our insect pests of considerable importance have scarcely been studied at all, and even the boll weevil, which has possibly received as much attention as any one insect, still offers great opportunities for highly trained students along various lines.

We are told that at the present time the South is moving forward more rapidly than any other section of the country along educational, industrial, and agricultural lines, and that the greatest development during the next fifty years will occur in this region. There is every reason to believe that entomology in the South, and especially economic entomology, will keep pace with this general march of progress.

VICE-PRESIDENT W. P. FLINT: All of us must feel that our knowledge of certain phases of American entomology has been increased very much during the last twenty minutes.

The President's address is now open for discussion.

MR. L. O. HOWARD: In the last two months I have been devoting a certain amount of time to writing down things, and, as it happened, last week, I wrote something on entomology in the South. I am going to tear up what I have written and I am going to write it over again when this address is published. I am not going to say anything about the supremacy of Mississippi over all of the other states, because there may come a migration of the colored men from Mississippi into Illinois, and then the generalization will be altered. That is quite within the bounds of possibility.

I think we have seldom had an address of such a timely nature. It is an address that has impressed me enormously. I have had the advantage of having visited the state of Mississippi, and while I have not been at the A. & M. College, I have met a lot of Professor Harned's men in Gulfport and elsewhere. I found, not at all to my surprise, that the general opinion of Professor Harned throughout the state of Mississippi is a very high one. He is held in the greatest admiration and affection by his students and by his assistants.

I am convinced that when we come to realize the good he has done to the South and the hold he has gained among the agricultural and scientific people of Mississippi, we must add to the list of H. A. Morgan, W. D. Hunter and Wilmon Newell, the name of R. W. Harned. (Applause.)

MR. E. P. FELT: One of my associates, on the way down from the North, took occasion to relieve himself of some rather derogatory views in relation to a presidential address and the necessity of listening thereto.

My impression is that Professor Harned has amply justified the presidential address. It has been to me a source of great pleasure and gratification to have the recital of what has been done in the South, and that prophesy of what may come in the future.

We need these discourses and summaries from different men. If some are not quite so fortunate as others, those who come after will find in this address something very difficult to match. I am immensely gratified. (Applause.)

MR. J. S. HOUSER: I would like to emphasize the optimistic point of view. As entomologists we have to look to the future for some of our compensations. I was also interested in what he said about Mr. Fleming. I had the pleasure of meeting Mr. Fleming a few years ago through Professor Harned's assistance, and I was impressed with the attitude he had toward entomological work. He was definitely an amateur on such things. I could see from what he said that he got his inspiration and a great deal of encouragement from Professor Harned on the work he was doing. (Applause.)

ADJOURNMENT: 4:20 p. m.

Wednesday Afternoon Session, December 28

The session convened at 4:20 p. m., First Vice-President W. P. Flint presiding.

FIRST VICE-PRESIDENT W. P. FLINT: The first paper on the program is by L. S. McLaine and H. G. Crawford.

THE STATUS OF THE EUROPEAN CORN BORER IN CANADA (1927)

By L. S. MCLAINE and H. G. CRAWFORD, *Entomological Branch, Ottawa*

ABSTRACT

The European corn borer, *Pyrausta nubilalis* Hubn., continued to spread in 1927 both in Ontario and Quebec. The infested area covers approximately 95,650 square miles, it extends 575 miles from east to west and 385 miles from north to south. Infestations have been found as far west as St. Joseph's island, 15 miles east of Sault Ste. Marie, and as far east as Batiscan on the St. Lawrence river, 50 miles west of Quebec city. An outbreak was discovered at New Liskeard, practically the northern limit of corn growing and 385 miles north of the original outbreak. With the exception of Essex and Kent counties there has been an increase in the intensity of infestation in Ontario. In Quebec the percentage of infestation is still less than one per cent. The corn borer was not found in Nova Scotia or New Brunswick. Control operations in Ontario were, on the whole, a success, but were very seriously handicapped by a wet fall and spring. Further investigational work on control needs to be done.

As a result of European corn borer scouting carried on in the provinces of Ontario and Quebec during the summer of 1927, it was found that this insect had invaded additional territory in both provinces. At the present time the total area in Canada known to be infested or placed under quarantine for economic reasons, is estimated at 95,650 square miles as contrasted with 3,000 square miles, the area known to be infested in 1920, the year the insect was discovered in Canada. The area involved in Ontario consists of 85,500 square miles, and in Quebec, 10,150 square miles. The additional territory found infested in 1927, is estimated at 8,500 square miles in Ontario and 9,400 square miles in Quebec. A total of sixty-two collections of European corn borer larvae were made by the scouts during the past summer, and fifty-nine of these were taken in districts which were not known to have been previously infested. The present infestation in the provinces of Ontario and Quebec occurs throughout a zone extending approximately 575 miles from east to west and 385 miles from north to south.

In a paper presented last year[1] mention was made of the fact that the European corn borer had invaded practically all the main corn growing sections of the province of Ontario. Scouting carried on in 1927 revealed quite a severe outbreak on Manitoulin island in lake Huron. This was the first time that the island had been examined, and the inspectors reported that collections were made in practically all fields visited, although the percentage of stalk infestation was very small. Collections were also made in the Algoma district as far west as St. Joseph's island, approximately fifteen miles east of Sault Ste. Marie. In 1926, an isolated infestation was found at North Bay, this past season other collections were made in the vicinity of this outbreak, at New Liskeard approximately 80 miles north of North Bay, and 385 miles north of the original outbreak at St. Thomas.

In Quebec province, in 1926, two isolated infestations were found, one across the Ottawa river opposite the city of Ottawa, and the second in the extreme southwestern portion of the province immediately north of the New York state line. In 1927, these two infestations were found to have merged. Isolated outbreaks have also been found on the north and south shores of the St. Lawrence river as far east as Batiscan village in Champlain county, approximately fifty miles west of the city of Quebec.

Scouting was also carried on in the provinces of New Brunswick and Nova Scotia in the principal sweet corn growing areas, but no sign of the insect was found.

Following the practice instituted some years ago studies were made at definitely established record points, to ascertain increases or decreases in the intensity of infestation. Only the percentage of stalk infestation was taken, and no attempt was made to determine the larval population per stalk. All points thus far established are in Ontario, the infestation in Quebec being far below one per cent. In Essex and Kent counties where from the time the insect was first discovered until this season there has been a decided increase each year, scouting in 1927 showed a decrease of approximately 49 per cent in Essex county and 43 per cent in Kent county. It may be said, generally, that in all other sections there has been an increase, this is particularly noticeable in counties in the Niagara peninsula as well as in Prince Edward county. The latter district is a sweet corn canning area, and an average of the 45 fields examined showed an increase in the average stalk infestation of from 2 per cent in 1926 to 15 per cent in 1927 or 650 per cent actual increase.

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[1] McLaine and Crawford, Status of the European Corn Borer in Canada (1926), Journ. Econ. Ent., Apr., 1927, p. 341.

Control operations are under the supervision of the Ontario Department of Agriculture and the writers are indebted to the Provincial Entomologist, Professor Lawson Caesar for the following information:

The Corn Borer Control Act[2] was enforced for the first time in 1926–27, when eight of the most heavily infested counties (Essex, Kent, Lambton, Elgin, Middlesex, Oxford, Norfolk and Prince Edward) were brought under its jurisdiction. In accordance with the regulations under the Act each individual property owner or tenant is required to clean up his premises, take care of crop refuse, etc., so as to control the corn borer, and such work must be carried out to the satisfaction of the Provincial Entomologist. Inspectors were appointed in the fall of 1926, and the balance of the year was largely confined to an educational campaign. The success of the campaign was very seriously handicapped by the extremely wet fall, which made fall ploughing impossible in many localities, and by an unusually wet spring. In spite of the obstacles and difficulties encountered, as well as the fact that the inspectors engaged in the field work were unfamiliar for the most part with regulatory work, it can not but be said that on the whole the campaign was a success. This is evidenced by the fact that there was a decided decrease in the borer population in the two most heavily infested counties, namely Essex and Kent. Professor Caesar also reports decreases in certain other counties whereas in others an increase has been noted. It has been decided to extend the Act, in 1927–28, to include that portion of Ontario south of a line extending from Goderich on lake Huron, to a point about eight miles north of Toronto and also an area about six miles in width along the north shore of lake Ontario from Toronto to the eastern boundary of Hastings county.

Extensive investigational work will have to be carried out along a number of lines, among the most pressing of which is the devising of improved methods of ploughing or other means to reduce the necessity for hand picking stubble and crop refuse remaining on the surface of the field.

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[2] Lawson Caesar. The Corn Borer Act in Operation. Ann. Rpt. Ent. Soc. of Ont., 1927.

First Vice-President W. P. Flint: The next paper is by D. J. Caffrey.

CORN BORER RESEARCH AND THE TEN MILLION DOLLAR CLEAN-UP CAMPAIGN

By D. J. Caffrey, *Entomologist, Division of Cereal and Forage Insects, Bureau of Entomology*

Abstract

The clean-up campaign provided an excellent test, under large-scale conditions, of the utility and practicability of the knowledge concerning the corn borer, *Pyrausta nubilalis* Hubn., obtained through research during the ten year period since the discovery of the insect in America. It provided also a rare opportunity to observe the effectiveness of various control practices and pointed the way to continued or additional research. The status of various effective and ineffective measures, as well as methods still in the experimental stage, were considered in deciding upon methods of procedure.

During the progress of the campaign the available entomological information proved adequate to secure effective results and the new or additional research activities suggested were chiefly mechanical or agronomic in nature. Noteworthy examples were (1)—Improvements in existing rakes, plows, plowing attachments and the methods of operating such equipment, (2)—Changes in certain rotations in certain areas, to allow plowing as a final touch to the "clean-up," (3)—Studies in combustion to better understand the performance of burning machines and ordinary burning operations, (4)—Corn breeding to produce varieties of corn characterized by stiff or rigid stalks to permit better functioning of certain corn harvesting machinery, as a phase of existing projects to produce corn tolerant to corn-borer attack, (5)—Importance of larval survival as a factor in influencing the intensity of infestation, (6)—Importance of retaining the strict clean-up regulations enforced during the campaign.

The surprising lack of knowledge concerning the corn borer exhibited by interested persons, despite unprecedented publicity, indicates the necessity of an intensification of the effort to acquaint the public with the practical information now available.

The appropriation of $10,000,000 to determine the feasibility of retarding the normal increase and dispersion of the corn borer, and the restriction of its numerical abundance below the point of serious commercial damage, provided an excellent test of the utility and practicability of the research work carried on during the ten year period which had elapsed since the presence of this introduced pest was discovered in America. It provided also a rare opportunity to observe the effectiveness of the various control methods when employed on a large scale and pointed the way to avenues of continuation for existing, or to the need for additional research.

In considering the critical problem presented by the menace of the corn borer during the spring of 1927, and the best methods of procedure, it early became apparent that plans for actual control operations must be based quite largely upon the knowledge, obtained through research, respecting the general biology of the corn borer, its habits as applied to suppression, the effectiveness of customary or special mechanical measures, regular or special farm practices, and the several control methods ordinarily employed in combating noxious insects.

Effective Measures

As a result of long continued research it was evident that the corn borer could be combated successfully by utilizing or destroying the corn plant and its residues before the adults emerged

Specifically this meant, in the area under consideration, that all infested corn fodder, corn remnants and other plant debris from infested fields must be disposed of by one or more of the following methods: (1)—By feeding to livestock direct from the field, or in the form of silage, or finely cut, finely ground, or finely shredded material. (2)—By plowing under *cleanly*, and deeply enough to insure that the turned-under material would not again be brought to the soil surface by later cultivation, or weathering, to act as a shelter for migrating larvae, before the moths emerged. This involved ordinary cultivation after plowing to close all large cracks and crevices in soils of heavy type (3)—By burning *completely* or exposing to sufficient heat to kill all contained larvae or pupae. This involved the poling (or cutting) raking and burning in piles, or windrows, of cornstalks and infested weeds in fields where corn was husked from the standing stalks; the burning of surplus shocks where this method of harvesting was practiced; and the burning of all cornstalks used in building shelters for livestock, for thatching, windbreaks and similar purposes, as well as cornstalks stored for feeding purposes, cornstalks along ditch banks and field borders, and large portions of unprocessed corn residues left in feed lots, barnyards and similar places unless trampled deeply into manure.

On the other hand all evidence showed that certain of the control measures, promising ultimate utility, could not be incorporated in the program. For example, trap crops could not be depended upon to produce the desired results. The use of insecticides, parasite introductions and varietal and seasonal planting tests were all in the experimental stage and had not advanced to a point where they could be assigned a definite value nor recommended with an assurance of effective aid.

INEFFECTIVE MEASURES

On the negative side of the scale, experiments and field observations had demonstrated that certain widely used farm practices were not effective in the suppression of the corn borer. Among such ineffective measures may be mentioned the disking of cornstalks or high corn stubble lands to small grains without previous treatment; the use of various tillage rollers, cultipackers, harrows and wide-tire tractors as agents of direct kill; pasturing with livestock; trap lights and attractants. Special projects had shown that high corn stubble contained a dangerously large proportion of the total borer population, in fact that, from an entomological viewpoint, the only "safe" corn stubble was that from cornstalks which had been cut at the ground level, and that 2-inch stubble was the maximum height which could be tolerated, without additional treatment.

APPLICATION OF ACCUMULATED DATA

All of the points previously mentioned were taken into consideration when framing the clean-up regulations and in formulating the plans for procedure under the large-scale conditions to be encountered. In this emergency it became necessary to discard many of the theoretical and abstract proposals for controlling noxious insects or limiting their damage, and to adopt only those methods which were known to be effective.

With respect to new or additional research activities suggested as a result of experiences during the "clean-up" campaign, it may be stated that such suggestions were chiefly mechanical or agronomic in nature. As the campaign progressed it became evident that the strictly entomological information at hand was adequate to secure effective results but that the application of mechanical processes of disposing of infested crop residues required improvement in the performance of regular or special farm machinery as well as a greater skill in its manipulation on the part of the ordinary farm operator.

A noteworthy example may be cited in the instance of existing types of rakes for gathering infested trash into windrows or piles, preparatory to burning. Unless handled with skill and judgment, such rakes usually left far too great a quantity of infested material on the soil surface and rendered hand-picking necessary as the only solution for completing a satisfactory clean-up, in instances where the finishing touch could not be supplied by plowing.

Many plows found in use were unable to meet the requirement of *clean* plowing, even in the presence of comparatively short stubble or small amounts of trash, while in other instances the possession of adequate equipment was nullified by improper adjustment of the plow or its attachments, or by carelessness on the part of the operator. These observations have naturally suggested obvious lines of research in agricultural engineering.

In many of the fields in the infested area, where spring plowing was the most practical method of completing a satisfactory clean-up, the soil conditions were such as practically to prohibit this operation, without seriously interfering with the prevailing crop rotation. (This was particularly true in the instance of corn lands intended for disking to small grains in the spring.) This problem rendered obvious the necessity of concentrating upon research respecting crop rotations which will permit plowing as a finishing operation to corn lands, under corn-borer conditions.

Burning operations, by machine or in the ordinary manner, were found to involve problems of combustion which have suggested an important research project to determine the influences responsible for the death, or the survival, of the corn borer when contained in cornstalks subjected to high degrees of heat for short periods but not consumed by the flames.

With the performance of farm machinery designed to cut corn close to the ground, there was found to be involved the important agronomic factor of erectness in infested cornstalks, at the time of harvest, to insure that the quantity of loose fodder and other plant debris left on the ground as "leakage," be reduced to the minimum. Since the agronomists are already engaged in the attempt to produce corn characterized by rigid or stiff stalks, as a factor of tolerance to corn-borer attack, this endeavor has received increased impetus.

During the course of the "clean-up" campaign an unusual opportunity was afforded to observe the influence exerted by the annual variation in the survival and establishment of young corn-borer larvae. It is well known that the percentage of establishment of the larvae is an important factor affecting the resulting intensity of infestation. Field research studies in connection with the "clean-up" indicated that in certain fields the percentage of larval establishment during 1927 was practically double that of preceding years. This development has stimulated the research projects, already in progress, to determine the influence affecting larval establishment, and has also emphasized the point that this factor must be given great consideration when considering the results of the "clean-up." It emphasizes also that the "clean-up" regulations in force during 1927–28 cannot be made less stringent if effective results are to be expected.

Although not precisely applicable to research, perhaps one of the most impressive lessons learned during the campaign, was the surprising lack of elementary knowledge exhibited by farmers, agricultural officials and other interested persons concerning the corn borer, and associated insects, although information respecting the insect has been disseminated widely and through every conceivable publicity channel during the past 10 years. Such publicity, according to a recent report issued by Dr. W. H. Larrimer, has included the publication of 796 bulletins, circulars, pamphlets, articles, etc., from various widely separated sources in America. It appears that one of the most important tasks before us is that of continued publicity, demonstration and extension work to acquaint persons intimately concerned, with the practical information now available.

First Vice-President W. P. Flint: The next paper is by W. H. Larrimer.

RESULTS OF THE TEN MILLION DOLLAR CORN BORER CLEAN-UP CAMPAIGN

By W. H. Larrimer, *U. S. Bureau of Entomology*

Abstract

The clean-up campaign was a "control experiment to reduce the number of corn borers (*Pyrausta nubilalis* Hübn.) in the infested area and slow down or prevent the natural spread of the pest." The number of borers in the clean-up area was greatly reduced, there being on an average 98 destroyed out of every 100. This resulted in holding the infestation in 1927 to just about the same intensity as it was in 1926. Where the thinly infested border of the infested area was thoroughly cleaned up, the natural spread was slowed down but not prevented. Where this border infestation was not thoroughly cleaned up, considerable spread occurred.

In a statement furnished by the United States Department of Agriculture to the appropriations committees of the Sixty-ninth Congress the ten million dollar corn-borer clean-up campagin was defined as "a control experiment to reduce the number of corn borers in the infested area and slow down or prevent the natural spread of the pest." It is well to keep this expressed purpose in mind in any discussion of the results of the campaign.

While there were innumerable indirect, and many direct, results of the campaign, such as its far-reaching educational value, the demonstration of the fact that "it could be done," and that such unprecedented cooperation was possible, the present discussion will be confined to the main purpose as stated: First, the reduction in number of the corn borers; and, second, the natural spread.

CORN BORER REDUCED IN NUMBERS

As an indication of the effectiveness of the clean-up in reducing the corn-borer population and in order to determine what might be considered an acceptable standard of clean-up, surveys were made to serve as a basis for estimates of the number of borers present both before and after the work was done. Table 1 lists the districts where these surveys were made and the respective percentages of reduction in the borer population. For the entire area a reduction of 98% is indicated, which means that 98 borers out of every 100 were killed by the various clean-up methods.

TABLE 1. THE APPARENT REDUCTION IN CORN-BORER POPULATION AS A RESULT OF THE CLEAN-UP CAMPAIGN

District	Reduction, %
Monroe, Michigan	99
Bono-Reno, Ohio	98
Sandusky, Ohio	96
Silver Creek, New York	97
Average	98

As additional evidence on this point, as well as an indication of the effect of such a reduction in the number of overwintering corn borers, on the next generation, the results of the annual infestation surveys are available. Table 2 briefly summarizes the more important of these results.

TABLE 2. RESULTS OF THE EUROPEAN CORN BORER INFESTATION SURVEYS 1925, 1926, 1927

State	Per Cent Infested			Borers per Infested Stalk			Borers per 100 Stalks		
	1925	1926	1927	1925	1926	1927	1925	1926	1927
Michigan	1.10	4.04	9.56	1.36	2.88	2.86	1.50	11.62	27.33
Ohio	1.48	2.30	2.45	1.29	2.49	2.21	1.90	5.72	5.43
Pennsylvania	1.28	2.06	7.99	2.08	3.45	3.03	2.66	7.11	24.24
New York	1.56	5.20	5.78	2.87	2.33	1.72	4.48	12.10	9.94
Area	1.35	3.23	5.50	1.56	2.73	2.61	2.11	8.82	14.34

The number of borers reported for the whole campaign area is 14 per one hundred stalks as compared with 9 per 100 stalks in 1926. In Ohio and New York there were decreases in the number of borers per one hundred stalks. In Ohio the decrease was from 6 borers per hundred stalks in 1926 to 5 per hundred stalks in 1927. In New York the de-

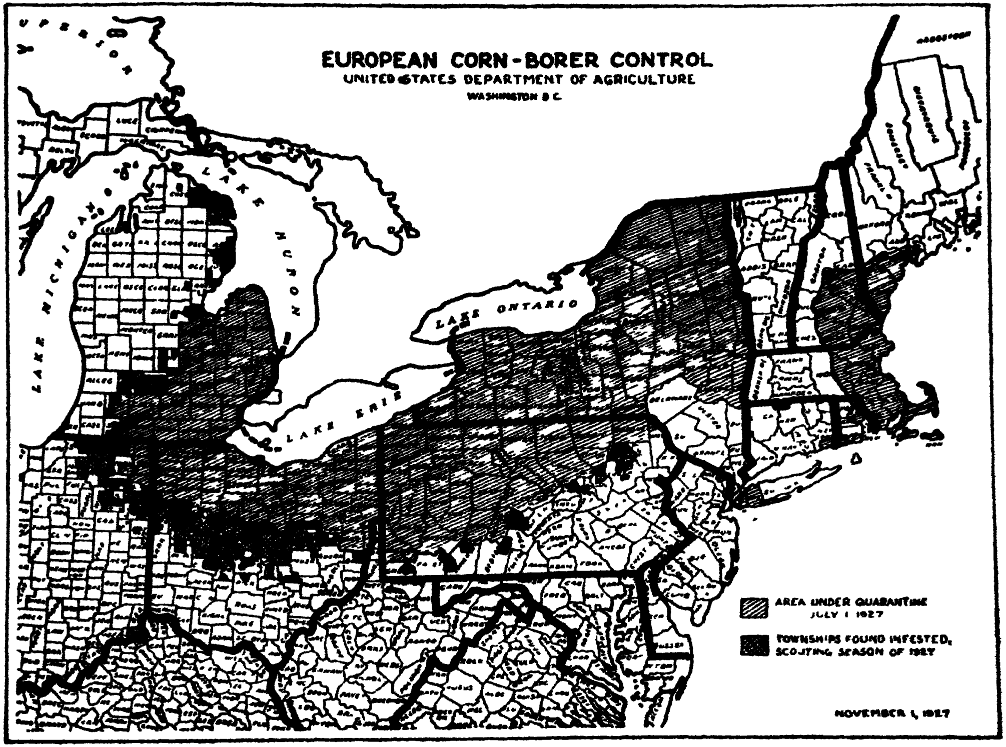
EUROPEAN CORN-BORER CONTROL
UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON D.C.
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO
▨ AREA UNDER QUARANTINE JULY 1 1927
■ TOWNSHIPS FOUND INFESTED, SCOUTING SEASON OF 1927
NOVEMBER 1, 1927

Fig. 1.—Area infested by European corn-borer to November 1, 1927. The cross hatched portion was found infested during 1927.

crease was from 12 borers per hundred stalks in 1926 to 10 in 1927. In Michigan and Pennsylvania there were increases as follows: In Michigan 27 borers per hundred stalks in 1927 as compared with 12 in 1926, and in Pennsylvania 24 borers per 100 stalks as compared with 7 in 1926. None of the counties in Indiana was included in the survey as the infestation is as yet less than one borer per 100 stalks.

Considering the various adaptations of the insect, especially its powers of reproduction and the rate of establishment of the young larvae, the results of the debris counts and the infestation survey are quite in harmony. Over the entire area cleaned up, the borer population was held to just about the same in 1927 as it was in 1926. To those who are familiar with the corn borer, especially the entomologists, this will be recognized as a most remarkable accomplishment. In some instances where a special effort was made, a sustained reduction in infestation was obtained. Such was the case in Lucas County, Ohio, the most heavily infested county in the United States in 1926 and a habitat most favorable to the insect, where as a result of the clean-up the infestation was reduced from 70 borers per 100 stalks in 1926 to 42 borers per 100 stalks in 1927.

SPREAD

The map (Fig. 1) shows the entire area known to be infested by the corn borer and also designates those portions where infestations were discovered for the first time in 1927. While this later infestation doubtless represents in part the spread that occurred during the previous year or years, it is also evidence that considerable spread occurred in 1927. This might be taken to indicate that normal spread is a result of the flight of moths originally from the border of the infested area. In Michigan, where this border section perhaps was cleaned up more thoroughly than was the case for the corresponding section in Indiana and Ohio, the newly-discovered territory in general reaches the minimum. Furthermore, the clean-up reduced the heavier infestation along Lake Erie in Ohio, so any spread in that state must have come from a comparatively light infestation, while in Michigan, where there was an increase in infestation along the lake, very little spread was discovered. Although the evidence is not conclusive, it does seem sufficient to indicate rather forcibly that if success is to attend any further effort to retard the natural spread of the corn borer, the border of the infested area can not be neglected.

MR. F. N. WALLACE: I would like to ask if the border-line was neglected.

MR. W. H. LARRIMER: No. In the state of Ohio it was found to be infested.

MR. E. P. FELT: You mean less than one per cent?

MR. W. H. LARRIMER: Yes. The less-than-one-per-cent area and this was quite a bit larger than the cleaned area.

MR. E. P. FELT: Your suggestion in the paper is to the effect that less than one per cent should be cleaned up.

MR. W. H. LARRIMER: That is, begin at the outside rather than the inside.

MR. C. L. MARLATT: This discussion which has just been started touches the heart of the matter of preventing spread by cleanup operations. I do not know whether this is the proper time for a lengthy consideration of this subject. We, in the Department of Agriculture in Washington, however, will very possibly be confronted very shortly with the question of possible renewal of the demand for a special appropriation, perhaps larger than last year, for such cleanup to prevent spread.

The main argument for any such appropriation must be based, as it was last year, on the theory that such cleanup will reduce spread into new territory sufficient to warrant the expenditure. Taking up the work of the past spring, it is perfectly clear from the maps shown in the adjoining room that, in spite of the cleanup as then conducted, there was a large extension of corn borer into new territory in 1927—extension which was partly spread but undoubtedly partly merely discovery of spread of the year before. When the proposal of large-scale cleanup was presented to the Department it was under the distinct understanding that the cleanup was to be from the periphery inward, and that the main point of the cleanup was to retard spread, and this was the principal argument in support of the measure which was used by me in the presentation of it before the Budget and before both committees in Congress. As pointed out by Mr. Larrimer, after the work was well started it developed that conditions in Ohio were such that the State officials believed that it would be impossible to enforce the cleanup proceedings in the less-than-one-per-cent area, which meant a large percentage of the area known to be infested in that State. As already indicated, the principal thought was to prevent spread into the main Corn Belt, namely, to the southwest and west. Therefore, much of the Pennsylvania and New York area, and all the New England area, was excluded in the original plan for enforced cleanup operations. On the other hand, I believe that in Indiana and in Michigan the cleanup was extended rigorously to the extreme limits of the known infested territory.

The history of the natural spread of the pest in the past indicates that the rate ranges from 20 to 30 miles per year, and it is, therefore, obvious that such spread must come largely from the less-than-one-per-cent area which, in Ohio, has a width of 100 miles or more. It is perfectly clear, therefore, that if we intend to control the corn borer by cleanup operations, we must logically and reasonably include the border fringe. Referring again to the maps, it is clear that in Ohio particularly, and also in Indiana, apparently the normal spread took place. In Ohio the opportunity for spread is clear. In Indiana, however, there was considerable spread. Just how much of this was, however, due to failure to discover the spread the year before can only be conjectured. On the other hand, in Michigan there was very little spread, indicating a possible result of cleanup to the periphery. It is well understood that no cleanup will prevent spread, but only limit the numbers of individual moths concerned and by that means possibly reduce distance.

With regard to the situation as to abundance in the western area of the corn borer, it may be pointed out that in none of this area have the infestations reached a condition of commercial damage except in a few spots along the border of Lake Erie, and hence all spread in that area has come from lightly infested areas—most of it from less than one per cent. In this connection, it is interesting to note that in the eastern New York area, where there has been 19 years for opportunity for infestation of the crop, the infestation has never really reached a point anywhere of commercial damage or even injury such as the farmers would recognize. On the other hand, the insect has steadily spread from the original center until now it covers most of the eastern half of New York and has connected up with the western area.

As already indicated, my idea in opening up this discussion now is that the proposition to continue a large appropriation for cleanup work will undoubtedly be presented to Congress in the next few weeks and that if such proposition does come up and any appropriation is made for the purpose of preventing spread, it should be clear to all concerned that the expenditure should be made where actual spread occurs, beginning with the border or, better, a little beyond.

Another reason for this discussion is that the argument is being made by some who are backing this movement to perhaps confine the cleanup to what would be designated as the one-per-cent-plus area, which, if carried out, would mean work well within—namely, from 50 to 150 miles—the known margin of spread. Such a cleanup, in my judgment, would be merely a service proposition for the farmers in the area concerned and would have little, if any, effect in preventing spread. If the Federal Government goes into such service work in relation to the corn borer, it would seem logical that it must necessarily extend that work over the whole corn borer area, east and west, including New England, and, for that matter, why should not the Government do it also for the codling moth and the boll weevil or any other insect pest! Hence, any proposal of cleanup as a service proposition should be given very careful consideration before endorsement. In connection with the conference recently held in Washington with the International Corn Borer Committee, this situation was fully discussed and apparently a fair appreciation was reached on the part of the Committee of the necessity for making any cleanup work on the basis of prevention of spread—at least begin with the periphery and work inward.

On the other hand, the demonstration of work of last year was satisfactory and adequate with respect to the other perhaps less vital but still very important phase of corn borer control, namely, the question of the value of thorough cleanup as a routine and continuing method of preventing damage by the corn borer. With respect to this phase, therefore, the Department believes that further large-scale demonstration is not necessary, but, of course, there could be some argument made for a repeated demonstration as to that phase merely to add to the force of the demonstration of last spring. As we all know, the work of last year was done under very unfavorable conditions. The idea of such demonstration was late in coming forward. Congressional aid was very promptly given. Nothing of that sort has ever been done in such a short time. But there was a long delay in getting state legislation to give the adequate police powers to carry out the work. Following all this delay there was a most unfavorable season of rain. In spite of these obstacles, a really remarkable cleanup work was done, and the credit for that should go very largely to Mr. Worthley. He has demonstrated his ability in a very unusual way, handling a perfectly tremendous job, with a huge personnel, and bringing about a cooperation—State and Federal—which has been properly the subject of unstinted praise. The result demonstrated that cleanup was a very efficient means of reducing the corn borer population, and indicating a method which could be followed as a common practice, and should be followed as a common practice in all corn borer territory where this new pest is really a menace to corn culture. The problem we have before us is whether this work should be continued and, if it is continued, whether it should be for prevention of spread; in other words, along the periphery, or merely as a demonstration of efficiency of cleanup, somewhere in the interior of the corn borer area.

MR. E. P. FELT: Have you any idea as to how efficiently the spread could be prevented by border work?

MR. C. L. MARLATT: My idea on that subject would be simply a prophesy or a guess. I mentioned the fact that in Michigan it was peripheral work. I am right, I think, in that, Mr. Larrimer?

MR. W. H. LARRIMER: Yes.

MR. C. L. MARLATT: The spread was there checked apparently, yet the opportunity for spread was there greater because the corn borer population was heavy on the Lake border. The interesting point is the large area left untouched in Ohio and the very wide spread or discovery which is indicated for 1927.

MR. F. N. WALLACE: If that were a little more in Indiana would that account for it going 65 miles along a little, narrow lane? I will say, frankly, the cleanup was just as effective as it was in Michigan, yet the spread shows 65 miles farther along the Indiana line. It is practically an imaginary line directly west, 65 miles along the Indiana line. It shows on the map.

MR. C. L. MARLATT: I am sorry Mr. Worthley is not here.

MR. F. N. WALLACE: I am too.

MR. C. L. MARLATT: He would explain it better than I could. There is this explanation, however, which was given to me by Mr. Worthley, namely, that as a result of the large appropriation it was possible to make a much more intensive and wider survey to determine possible spread than in previous years, and, therefore, a good deal of the supposed spread in Indiana may be not spread of 1927, but spread of the previous year or years not theretofore discovered.

MR. F. N. WALLACE: The clean-up campaign last year was based on a clean-up over the entire known area. The Department and the states of Indiana and Michigan went into it with that idea. Ohio fell down on the regulation, but that had the approval of the Department in Washington, which I don't believe ever should have been given. The campaign should have stopped right then in Ohio, and the Department should have said, "This is a clean-up campaign to prevent the spread," and not say, it was a demonstration, because it was a real effort to prevent the spread. That is what I thought we went out for. That is what Indiana went in for and that is what Indiana is hoping to do now, to prevent the spread. We haven't any one per cent infestation in Indiana. I did not go to Washington to get a clean-up back in the heavily infested area. We are going to ask for the clean-up campaign. If the scouts can't get out and find it, that is not our fault. The scouting is done from the Department of Agriculture. If they are thirty miles behind it, they had better get caught up on it. It is not our fault.

Mr. C. L. Marlatt: In answer to Mr. Wallace, and as I have already partly indicated, there was a double purpose in this appropriation. The primary purpose was to prevent spread, but an important secondary purpose was the demonstration, already alluded to, of clean-up as a local or farm control measure. The original idea of the Department, as indicated, was that the work was to be done inward, including the periphery, in such a way as to be a demonstration of both possibilities. The farm control possibility has been demonstrated to our satisfaction. The other has not, except inferentially as a result of the reduction of population in the areas actually cleaned. The failure of the other in Ohio was, as I have indicated, not due to the Department, but came along after the work had already been provided for and was well under way, due to the announced inability of Ohio to exercise the necessary local police control in the less-than-one-per-cent area.

Mr. J. S. Houser: I think we might well take into consideration, before we go into a program of working in the outlying lightly infested area, the attempt to control and decrease the spread of the European corn borer. I am wondering, Dr. Marlatt, if we really have enough information on the spread of the European corn borer—the method of spread—to warrant that kind of action? Do we know enough about the distance of flight of the insect to warrant us taking a 30 mile area on the outside of the infestation and concentrating our efforts on that area, leaving the heavily infested area to take care of itself?

Mr. C. L. Marlatt: There is no heavily infested area within 100 miles of the border. I was referring to the 20 or 30 miles as the natural annual spread of the borer. There was not, nor is there now, any thought of restricting clean-up to a 30 mile area, but that the clean-up should go to the border.

Mr. J. S. Houser: I misunderstood the remarks, but it does seem to me that we do need some additional information on the spread of the insect, particularly on the flight. From our records we have not been able to find the moths flying strongly at a height of 50 feet. If we had additional money for research, we might have at least a partial answer to that question. I hope that the Bureau of Entomology may give us some information on that point next year. I think it is a very essential point.

Mr. C. L. Marlatt: Doctor Felt has some information on the height to which insects normally fly.

Mr. E. P. Felt: I feel we have not had enough information in regard to the European corn borer situation.

It is stated that the spread must be from the border, possibly, perhaps probably, but not certainly. When we go through item after item in relation to this insect, we come right down to that, possibly but not certainly. There is a great demand for further research in regard to some fundamental,problems. I am willing to admit at the outset that these questions, even with the amplest of resources, cannot be answered in a week or a year, or perhaps in five or ten years. The European corn borer is an important insect, and we ought to have something more definite than we have had in regard to just what it does.

In the case of New York state and the observations of Professor Transeau in Europe, I believe we can match in New York state, in very general terms at least, the conditions which he observed there, but we have not information in this country to justify us in going out and saying that such really obtains; we think so; we think many things about the European corn borer. We know comparatively little.

Mr. C. L. Marlatt: You have not given the altitude experiments, Doctor.

Mr. E. P. Felt: I cannot give you anything in regard to the altitude experiments in relation to the European corn borer, but since Dr. Marlatt has asked for something about that, I would say this—by all means, spend some money and find out whether the moth goes up to any great height. I would like to know, for one thing, whether the moth habitually crosses Lake Erie.

In regard to this Japanese beetle, not the one of New Jersey, but the *Aserica castanea* Arrow, found in this country several years ago, I found it the past summer on the roof of a thirty-story building in New York City, and several of them on the roof of a thirteen-story building in Mount Vernon.

When you get data like that you find out exactly what an insect is doing, what its limitations are, and what the possibilities are. With such information we can discuss intelligently how spread may be controlled.

MR. C. L. MARLATT: I think Dr. Felt told me he conducted this method of collecting the insects on the top of large buildings in Albany, but, among other things, he said he failed to catch a single corn borer moth. That is what I was trying to bring out!

MR. J. S. HOUSER: In this connection I would say there is a great mass of reflected light over a large city and that this undoubtedly would repel the moths from the vicinity.

MR. C. L. MARLATT: The question is not so much where the spread comes from but the fact that natural spread has been limited, and in my somewhat dogmatic statement I did not mean to indicate that it might not under very favorable conditions perhaps come from interior points, but would any of us be willing to say that if we began our clean-up work 50 miles within the border such work could really be rated as for the purpose of preventing spread?

MR. E. D. BALL: When you talk about the altitude of flight, we have innumerable records of 1400 feet and above, insects being found on the top of the Rocky Mountains, showing there are dense swarms of insects flying even higher than that. A question of 400 feet up in the air is not a migratory impossibility of the moth.

I was rather pleased to find myself—I am not going to say for the first time—in complete agreement with Dr. Marlatt. While I am, at the same time, in agreement with Dr. Felt and Mr. Houser, I would like to call attention to this fact, while I appreciate the appeal for the money, when it comes to finding out all of these facts, Dr. Marlatt is right. You have to do something now; you can't wait; you have to work on the information you have. If the information you have indicates you have been lacking in cleaning up the periphery, you can't wait for any information about the flight of the moth or anything else. You have to decide to clean up the periphery or let it go. By the time you find out, the opportunity will be gone. Dr. Marlatt is perfectly correct, you have to work on the interpretation of what you have now. That is the way it looks to me.

At the same time I appreciate the fact we ought to have this information and that money ought to be spent to get it, but the next step has to be taken on the basis of existing information.

First Vice-President W. P. Flint: The hour is now 5:15 and we are nearly caught up with the program for the day. Do you wish to continue with the reading of the papers, or do you wish to adjourn at this time?

Adjournment: 5:15 p. m.

Thursday Morning Session, December 29

The meeting convened at 9:40, President R. W. Harned in the Chair.

President R. W. Harned: The first paper this morning is by D. J. Caffrey and L. L. Huber.

THE FUNDAMENTAL PHASES OF EUROPEAN CORN BORER RESEARCH

By D. J. Caffrey, *Division of Cereal and Forage Insects, Bureau of Entomology*
and L. L. Huber, *Department of Entomology, Ohio Agricultural Experiment Station*

Abstract

Five years of experimental work and research with the European corn borer, *Pyrausta nubilalis* Hubn., in the Corn Belt have indicated that the ultimate solution of the problem is associated apparently with mechanical measures, parasites, insecticides and cultural practices. Parasites do not offer hope of immediate relief. Insecticides have been made the subject of exhaustive research. Cultural practices, particularly the late planting of corn have proved sufficiently promising to warrant a trial of this method, when and where necessary, in conjunction with or supplementary to the clean farming practices of the present. In addition to the entomological phases it is expected that agronomists will develop varieties of corn better adapted to corn borer conditions and that agricultural engineers will improve and facilitate clean farming operations. Sufficient progress has been made to warrant the belief that through continued efforts in all practical phases of research we will learn to grow corn profitably despite the corn borer.

Introduction

After five years of experimental work and research on the corn borer problem as it presents itself in the corn belt it may be of some value to indicate what is believed to be the practical aspects or the fundamental phases of the problem.

MECHANICAL CONTROL

The control of any insect pest is generally accomplished by the employment of one or more of the following methods, viz., by mechanical means, by parasites, by insecticides or by cultural practices, excluding the influence exerted by climatic conditions. It must be obvious, however, in case of the corn borer, that of these four possible methods of defense, mechanics was the only one immediately available for use. While the exact value of mechanical control was unknown, yet it was generally agreed that the greater the number of larvae killed, the less the number of moths, eggs and larvae should there be to deal with the succeeding year. It was evident, too, that in order to carry out a clean farming program it would be necessary to stress the use of the already existing farm equipment. It immediately became the task of the entomologist, therefore, to determine the comparative efficiency of the various types of equipment used under various conditions and circumstances. During the past five years a satisfactory check has been made on the efficiency of practically every important unit of regular farm equipment and specially designed machinery. Based upon this information it next became the duty of agricultural engineers to attempt to make farm machinery more efficient in killing borers and the further duty of economists and others to determine whether the suggestions of entomologists and engineers were economically sound and within the limits of practical farm operations.

That the continuance or the additional employment of clean farming practices has been of great importance in keeping infestation lower than it would have been without mechanical control is scarcely to be doubted. Ecological investigations, however, both at home and abroad indicate that the control of the corn borer will be a fairly simple matter in some areas but probably more difficult in certain other areas. Just how complete control, therefore, may be expected from clean farming alone, needs further investigation.

PARASITES

The possibility of securing an important measure of corn borer control through the medium of the natural enemies of the pest, particularly its insect parasites, has commanded keen interest. Great emphasis has been placed, therefore, upon this phase of the research activities.

Studies of the native insect parasites of the corn borer have shown that less than one per cent of the total borer population, on an average, was being destroyed by the combined activities of the native parasites. Whether these native parasite will exhibit an increasing tendency to adopt the introduced European corn-borer as a host, depends upon the future adaptability of these species.

Since research with the native parasites in the corn belt soon demonstrated that such species were of little consequence as natural checks, the next logical step was to import insect parasites from the original home of the corn borer in Europe.

A total of 12 species, consisting of nearly 400,000 individuals, were imported during the period from early in 1920 to the present date (November 15, 1927). These importations have been supplemented by laboratory breeding involving the production of an additional 1,700,000 individuals. Briefly, a total of approximately 2,000,000 parasites has been imported, bred and liberated at strategic points in the United States. Six of these species have been recovered in the field, under circumstances indicating their probable permanent establishment.

The details regarding the collection, rearing, breeding, liberation and recovery of these imported species involve many complicated problems which must be solved by continued research. It is proposed to extend these research activities, at home and abroad, looking toward the importation of all desirable species, supplemented by adequate breeding operations in the laboratory.

INSECTICIDES

Although the application of insecticides invariably has proved ineffective in protecting growing corn from injury by the European corn borer in all experiments conducted up to the present time, this development has not discouraged us from continuing to seek remedial measures of relief through the medium of insecticides.

The more important insecticides involved in these tests include the following substances employed alone or in various combinations as a dust or as a spray: lead arsenate, calcium arsenate, magnesium arsenate, nicotine dust, nicotine sulphate, sulphur, nitrobenzol, calcium fluosilicate, sodium fluosilicate, derris, paraffin oil, calcium cyanide, various silico-fluoride combinations, hydrated lime, and various patented preparations.

While none of the insecticidal materials or methods tested, to date, can be recommended for practical use in combating the corn borer, the objectives sought and the results secured are of sufficient value to justify a continuance of the experiments now in progress and an intensification of the effort to develop effective materials.

Cultural Practices

One of the most important responses of the corn borer to its environment is its response to time of planting corn. It has long been known that corn planted early will contain more borers than corn planted late. Potential infestation is automatically reduced by late planting. In the light of present knowledge, therefore, it appears that the condition of corn, whether it is good or poor, early or late, is a factor of very great importance in the decrease or increase of the borer population of any area. It would seem, therefore, that if we could modify the environment by planting corn at a later than normal date we would thereby escape commercial loss. In this connection it may also be pointed out that some varieties of corn are more tolerant than others, although they show no apparent differences in susceptibility to infestation. Thus far, however, no variety has been demonstrated to be immune.

These general entomological facts have pointed the way to experimental and research work along agronomic lines. It, therefore, has become the immediate task of the agronomists in cooperation with the entomologists to supply not only more tolerant varieties than we now have but to develop varieties that can be planted late and still produce a profitable crop. While the task promises to be long and tedious, there are some signs of hope and reasons for optimism.

Conclusions

From the standpoint of entomological research and experimental work it may be concluded that, parasites do not offer much hope of immediate relief. Insecticides are the subject of exhaustive research. Furthermore, investigations along the line of cultural practices have been sufficiently promising to warrant a trial of later planting when and where necessary but always in conjunction with or supplementary to the clean farming practices of the present. In addition to the entomological recommendations there are the further possibilities that the agronomists by their researches will ultimately provide varieties better adapted to corn borer conditions and the engineers through their investigations will facilitate and improve clean farming operations. It would seem, therefore, that sufficient progress has been made to warrant the belief that through our continued efforts in all the practical phases of research we will ultimately learn how to grow corn profitably despite the borer.

PRESIDENT R. W. HARNED: The first paper on the symposium is by W. S. Abbott.

RECENT DEVELOPMENTS IN PROPRIETARY INSECTICIDES

By W. S. ABBOTT, *Vienna, Virginia*

ABSTRACT

Considers some of the recent developments in proprietary insecticides, including the oil extracts of pyrethrum, derris, the nicotine dusts, the fluosilicates and internal remedies for external parasites. Also discusses the changes in policies and general attitude of insecticide manufacturers during the last few years.

(Paper withdrawn from publication)

PRESIDENT R. W. HARNED: The next paper is by S. Marcovitch.

THE RELATIVE TOXICITIES OF ARSENICALS AND FLUORINE COMPOUNDS TO VARIOUS ORGANISMS

By S. MARCOVITCH, *Entomologist, Tennessee Agricultural Experiment Station*

ABSTRACT

Mosquito larvae were used for the determination of toxicities of stomach poisons. With the formula $K = \frac{1}{t} \log \frac{1}{\text{conc.}}$ the following values of K, a constant for the expression of toxicity, were obtained against *Culex quinquefasciatus:* Sodium fluosilicate 32.1, sodium arsenite 9.6, sodium arsenate 3.5, and sodium fluoride 3. On grasshoppers, sodium fluosilicate used at the rate of 1–56 in poison bran baits showed 100 per cent mortality within 48 hours, whereas sodium arsenite gave 89 per cent. With the cutworm, *Feltia ducens*, sodium arsenite gave a kill of only 57 per cent within 72 hours, while sodium fluosilicate showed a mortality of 88 per cent.

Against mammals the arsenites are nine times more toxic than sodium fluosilicate and thirty times more toxic than sodium fluoride. Since there is evidence that minute amounts of arsenic, ingested daily for prolonged periods of time, may interfere with health, it is advocated that the subject is of such importance as to warrant investigation by a "Referee Board."

INTRODUCTION

Many chewing insects, among them the Mexican bean beetle, potato beetle, and boll weevil, were controlled experimentally in 1924 by the use of a commercially available chemical, sodium fluosilicate (5), instead of the well known arsenicals. The writer's interest was aroused as to the toxicity of this fluorine compound to insects as compared with the arsenicals and especially as to its poisonous effect upon man. Since little information was available at that time, the writer has devoted the last three years in research on this problem. An attempt was made to determine the numerical toxicity values of stomach poisons as a guide for future standardization and procedure. The systemic effects produced by fluorine compounds were also considered. Mosquito larvae and grasshoppers appeared to be best suited for the experimental work with the insects. Rabbits were used for higher animals and *Paramoecium* and *Lumbricus* as representing the lower animals. The experimental work with mammals was conducted while the writer was pursuing graduate study in the Department of Pharmacology at the University of Minnesota. A detailed report of these investigations is being prepared for publication in the near future.

TOXICITY STUDIES WITH INVERTEBRATES

For the determination of the relative toxicities of such inorganic compounds as the fluorides and arsenicals, the larvae of the Culicidae proved especially well adapted, since they are abundant, easily obtained or bred, and live in a medium which lends itself readily to chemical changes of any desired concentration. The time when cessation of movement was observed was taken as the measure of toxicity. Death takes place primarily by the oral ingestion of the chemical. Time does not permit a full discussion of the large number of compounds tested, hence only a few of especial interest will be considered.

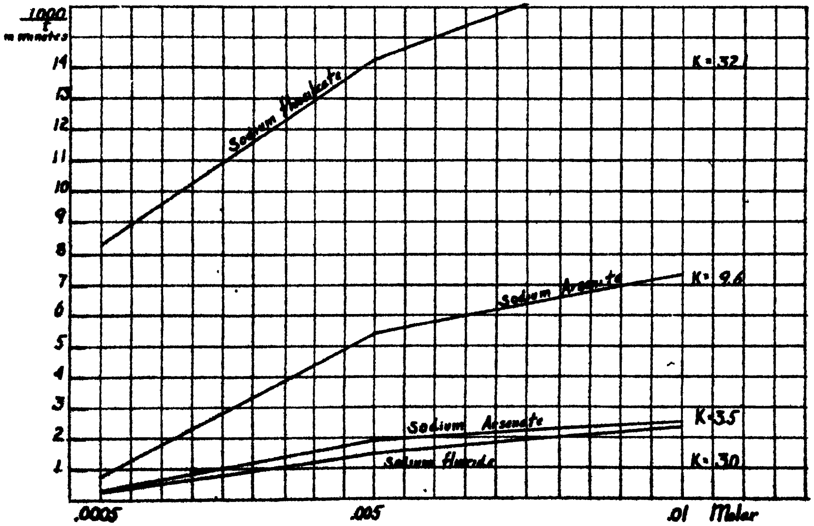

Fig. 2.—Velocity of fatality to *Culex quadrifasciatus.*

Sodium fluosilicate at .01 molar (1–532) produced 50 per cent mortality of the larvae of *Culex quinquefasciatus* within 55 minutes, whereas at the same concentration sodium arsenite required 135 minutes, sodium arsenate 390 minutes, and sodium fluoride 420 minutes. A parallel series of survival times was secured with concentrations of .005 and .0005 molar as indicated in Table 1. An inspection of Figure 2 where the concentration is plotted against the reciprocal of the survival time (the velocity of fatality) reveals a curve similar to the action of lead nitrate on *Leuciscus phoxinus* as worked out by Carpenter (1). This curve appears to correspond to the equation $K = \frac{1}{t}\log\frac{1}{\text{conc.}}$ where t = survival time and K a constant expressing a numerical value of toxicity. With such an equation we get a value of K for sodium fluosilicate of 32.1, sodium arsenite 9.6, sodium arsenate 3.5, and sodium fluoride 3. Sodium fluosilicate is thus ten times more toxic than sodium fluoride.

TABLE 1. TOXICITY STUDIES ON *Culex quinquefasciatus* AT A TEMPERATURE OF 75°F. GIVING SURVIVAL TIME OF 50 PER CENT MORTALITY

$$K = \frac{1}{t}\log\frac{1}{\text{conc.}}$$

	Molar Conc.	Survival Time (In min.)	Reciprocal $\left(\frac{1000}{t}\right)$	Value of K[1]	Aver. Value of K	Calculated Value of t
Sodium fluosilicate	.01	55	18.1	36.2		63
	.005	70	14.3	32.9	32.1	73
	.0005	120	8.33	27.4		104
Sodium arsenite	.01	135	7.40	14.8		222
	.005	180	5.55	11.5	9.6	255
	.0005	1260	.79	2.6		366
Sodium arsenate	.01	390	2.56	5.1		571
	.005	510	1.96	4.5	3.5	657
	.0005	2880	.34	1.1		943
Sodium fluoride	.01	420	2.38	4.7		666
	.005	660	1.51	3.4	3.0	767
	.0005	2880	3.4	1.1		1,110

[1] Calculated as $\frac{1000}{t}$ to avoid fractions.

In a concentration of 1–100 the fluorides of calcium, magnesium, strontium, copper, barium and lead produced 50 per cent mortality in 84, 54, 55, 6, 3 and 1½ hours, respectively. At the same concentration sodium fluosilicate required but 45 minutes. The insoluble arsenicals, calcium arsenate, lead arsenate, and Paris green killed in 11, 4 and 1¾ hours, respectively. The interesting point to be noted here is that lead arsenate showed a greater toxicity than calcium arsenate. If the calcium arsenate is allowed to remain in the water three days before testing, it becomes equally toxic. Hydrolytic action appears to be responsible for the production of a more toxic derivative of calcium arsenate.

Melanoplus femur-rubrum was also used in toxicity studies. Definite strengths of soluble materials were added to poison-baits. The hoppers were starved for 24 hours, after which period they showed greater uniformity in their desire to feed. The data thus secured checked well with those obtained with the *Culex* larvae. Mr. W. W. Stanley, Assistant Entomologist, carried out these bait experiments and also those with cutworms. Under the above conditions sodium arsenite (1–56) produced 89 per cent mortality within 48 hours, whereas sodium fluosilicate gave 100 per cent. This confirms the work of Langford (3) who also found sodium fluosilicate to be more toxic than sodium arsenite to grasshoppers.

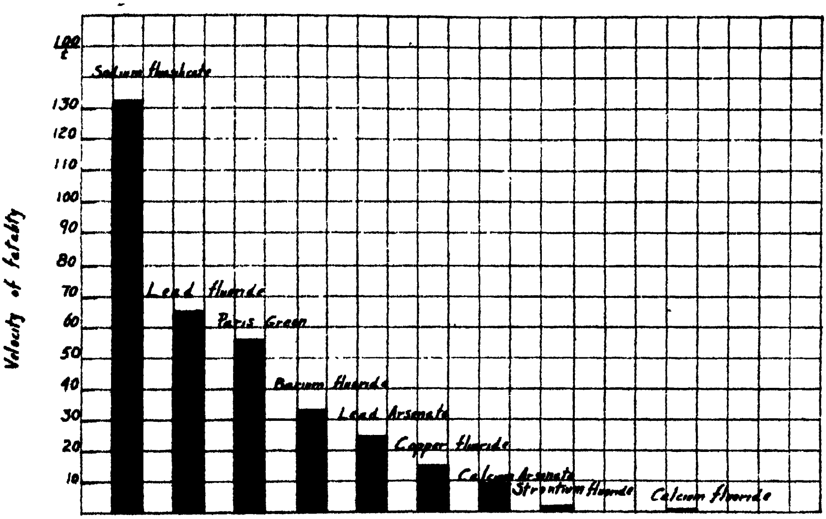

Fig. 3.—The relative toxicities of arsenicals and fluorine compounds to *Culex quadrifasciatus.*

In the cutworm experiments with *Feltia ducens*, sodium arsenite gave a kill of only 57 per cent within 72 hours, whereas sodium fluosilicate showed a mortality of 88 per cent. Since Ripley (7) has shown that the arsenicals have a repellent effect on cutworms and since no such effect has been shown for the fluorides, it is quite possible that this difference may explain the established superiority of the fluorine compounds. Moreover, poison baits with sodium fluosilicate were found to be distasteful to chickens. This is of considerable advantage when baits have to be used in the proximity of poultry or game birds.

The fluorine compounds were also studied on organisms lower than insects. With *Lumbricus terrestris*, sodium fluosilicate, sodium fluoride and sodium arsenite in concentrations of 1–1000 required 20, 40, and 240 minutes to produce a lethal effect. For protozoa, *Paramoecium caudatum* was used. A solution of sodium fluosilicate 1–10,000 is almost instantaneously fatal; the same strength of sodium fluoride produced a kill within 60 minutes, whereas sodium arsenite appeared non-toxic. Similar results were secured with *Euglena* sp

EFFECT OF FLUORINE COMPOUNDS ON VERTEBRATES

After the experimental work had shown that the fluosilicates are more toxic than the arsenicals to many of the lower organisms, the next consideration was their relative toxicities to man and the higher animals. The systemic effects of fluorine appear to be caused by the precipitation of an element which is essential for proper permeability, that is, calcium.

The more extended use of fluosilicates as dusts on plants leads to the question of the effects on human health when small quantities are ingested over a prolonged period, as well as the poisonous nature of a single large accidental dose. With rabbits the minimum fatal dose of sodium fluoride by mouth was found to be .5 gram per kg., and for sodium fluosilicate .12 gram per kg. For comparison with arsenic the soluble potassium arsenite required 14 mg. per kg. To estimate the effect on man, we find that the minimum lethal doses would be 30 grams of sodium fluoride, 7.2 grams of sodium fluosilicate, and .84 of a gram of potassium arsenite. Potassium arsenite is, therefore, about nine times as toxic to man as sodium fluosilicate, and 30 times as toxic as sodium fluoride.

No direct experimental evidence was obtained as to the effect of continued daily administration of very small quantities, although a few scant references in the literature throw some light on the subject. Sollman (8) found that daily doses of 8 mg. of sodium fluoride per kg. administered to rats showed no deleterious effect on growth or food consumption within nine weeks. Fifteen to 150 mg. per kg. resulted in a progressive impairment of both growth and food consumption, with little mortality and no histologic lesions. Christiani and Chausse (2, 3) conducted their experiments with guinea pigs over a period of several years, and found that daily doses of 10 mg. of sodium fluoride for 10 months caused no apparent harm. With sodium fluosilicate, however, a daily feeding of 8–10 mg. was harmless to one of two animals used, whereas the other died within 233 days.

O'Kane (6) fed guinea pigs with various amounts of lead arsenate. Daily doses of 1.7 mg. to 11.9 mg. were not fatal over a period of 30 days, although a daily dose of 13.6 mg. was fatal within 22 days. Since the therapeutic dose of arsenic to humans is 2 mg., O'Kane concludes that sprayed apples "offer very slight danger, provided rains have intervened after spraying."

Sollman (9) continued his feeding experiments with arsenicals on albino rats for a much longer period of time (9 to 24 weeks) and obtained some remarkable results. Daily doses of arsenic trioxide so small as .00005 to .0005 mg. per kg. produced a distinct retardation of growth. A marked loss of weight occurred with daily doses of .0015 to .005 mg. per kg. These daily doses are only 1/800 to ¼ of the U. S. P. therapeutic dose of two mg. More data on the cumulative action of arsenic over extended periods of time are necessary for the drawing of safe conclusions, but the evidence from these experiments would indicate that extremely small amounts of arsenic—such as found on apples—may impair human health, if administered over a period of six months.

CONCLUSION

As the white rat is a standard for pharmacological studies, so the mosquito may be employed for insect toxicology. For insects and lower organisms, sodium fluosilicate is more toxic than sodium arsenite. Since fluorine appears to affect the precipitation of essential calcium from the tissues, the meagre calcium content of the lower organisms may account for their susceptibility to fluorine compounds. By the aid of the formula $K = \frac{1}{t} \log \frac{1}{\text{conc.}}$ a numerical toxicity value of 32.1 was to be obtained for sodium fluosilicate, 9.6 for sodium arsenite, 3.5 for sodium arsenate, and 3. for sodium fluoride. On the other hand, to man and the higher animals, the arsenicals are at least nine times more toxic than sodium fluosilicate and thirty times more toxic than sodium fluoride.

Data as to the consequences of the continued daily administration of minute quantities of arsenic are too fragmentary and conflicting to formulate dependable conclusions. In order to estimate the effects of small daily doses of arsenic on man, more reliable results may be obtained by using the omnivorous rat, rather than with herbivorous animals. Sollman's work with the rat shows that daily doses of arsenic trioxide of only 1/800 to ¼ of the U. S. P. therapeutic dose of 2 mg. did produce a distinct retardation in growth within 9 to 24 weeks. This subject—the possible effect of arsenic on public health—is worthy of careful consideration by a referee board invested with the authority to investigate this problem in a comprehensive manner, to insure a better understanding for future guidance.

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PRESIDENT R. W. HARNED: The last paper of this series is by C. H. Richardson.

COMMENTS ON THE DETERMINATION OF THE RELATIVE TOXICITY OF INSECTICIDES

By C. H. RICHARDSON, *Bureau of Entomology, Washington, D. C.*

(Withdrawn for publication elsewhere)

MR. E. P. FELT: Dr. Richardson's paper dealt with the application of a summer oil. It gives the name of the manufacturer, but it gives no clue as to the composition. Our literature ought to be on a permanent basis. As a practical step in that direction I am suggesting that it might be well for papers of that character, or most papers—I have no objection to making it all papers—to give more accurate statements as to what the composition is; that is, put the formula in. Then we have a basis, or subsequent students have a basis, for comparison from year to year.

MR. C. H. RICHARDSON: I would like to say a further word on that point. If anyone goes back in the literature of oil using a trade name and attempts to correlate the results obtained, say, ten, fifteen or twenty years ago, with those obtained with the same or similar brands of oil today, you are left with the proposition as to whether these various brands of oil are the same. We have direct chemical information in a number of cases that the manufacturers have changed, and changed rather rapidly, the composition of the insecticide during the course of its manufacture. How are we going to make comparisons of toxicity on such a basis?

It seems to me the point that Dr. Felt has raised is very well taken, and is one which should be seriously considered in the publication of any results from insecticides.

MR. W. S. ABBOTT: I would like to further supplement that and say it would be of great value to the insecticide workers if the analyses of these preparations were given. I would like to give just one example of the extreme change in formula that we encountered several years ago. We picked up several samples composed of hydrated lime, sulphur and arsenate of lead, a very good combination, but there were certain changes on the label that we asked the manufacturer to make. Therefore, we checked up on this material. About a year later we collected not one but three or four samples of this same material with exactly the same label, exactly the same directions, but the material itself was pure hydrated lime. They left out the sulphur and lead. (Laughter.)

PRESIDENT R. W. HARNED: The next paper is by L. Haseman.

TESTING COMMERCIAL INSECTICIDES

By L. HASEMAN, *Columbia, Mo.*

ABSTRACT

The present extensive efforts to improve old and devise new insecticides is due to the increased demand for better insecticides. The investigations are vital to the advance of economic entomology and should be encouraged. On the other hand the many new materials appearing on the market as insecticides should be thoroughly tested before they are advertised and sold as insecticides. The economic entomologist in the various States should cooperate with the federal insecticide and fungicide board in preventing useless materials being placed on the market.

The ever-increasing problems in economic entomology requiring insecticides in their solution are largely responsible for the unusual interest shown by entomologists, chemists and manufacturers, in their investigation of old and new chemicals for insecticidal puposes. Never before have so many entomologists and chemists been at work on insecticides. Out of this present volume of research we seem certain to get new and improved types of insecticides. In the past most insecticides have been accidentally discovered and later improved by experimental work. At the present time specialists are scanning the field of chemistry for promising new chemicals or are attempting to improve on the present brands of insecticides.

These investigations are of vital importance to the future development of Economic Entomology and they should be encouraged. The activities along this line by the National Research Council and the Crop Protection Institute are especially commendable. Their efforts coupled with those of the various Federal and State Departments are sure to result in great improvements in our present insecticides.

While the scientists and the organizations which further these researches are deserving of special praise for their efforts, the manufacturers who assist with the work and who eventually must be depended upon to supply the insecticidal needs are also deserving of special praise. In many cases, they have their own trained scientific men who cooperate with the Federal and State men and in other cases they finance the investigations.

While this is all true and very desirable we cannot overlook the fact that there continues to appear on the market materials which are absolutely useless, of doubtful value or at best only imperfectly tried out. Such materials are often put out by new or small companies for quick profits or in some cases where the company has employed a young, inexperienced and over-zealous specialist who has some new discovery with which he expects to solve all our troubles in Economic Entomology. In some cases, however, old established firms rush upon the market with unproven products. In still other cases, the material is described as the results of years of study by an imaginary chemist. These are the types of insecticides which cause much trouble and which require constant watching. In this day and age when there is still so much of mystery associated with even the more familiar insect epidemics and so much misinformation available for the farmer's consumption he is too ready to invest in "cure alls," especially when they are convincingly advertised and promise spectacular results.

Fortunately we have the Federal insecticide law and the various State insecticide laws to help keep these questionable products in line.

The numerous Federal prosecutions are doing much to convince manufacturers that they must put on the market only such products as are of real service in controlling insect pests. This service is of immense value to the users of insecticides and every entomologist should consider it his duty to cooperate in making the enforcement of the Federal law effective. Without the hearty cooperation of State employees it is often very difficult for the Federal men to reach violators. With supervision over only interstate shipments it is easy for the intentional violator to escape the Federal regulations. Also by conducting their advertising and sales campaigns through channels independent of the label upon the container they are able to escape the Federal law. Where carefully drawn state laws supplement the Federal law and where the state workers cooperate with the Federal men the protection to the insecticide users can be made doubly valuable to them.

It is not the writer's intention to leave the impression that the insecticide business is a questionable one. The conscientious manufacturers are just as anxious to place a better product on the market as the entomologists are glad to see it. They are doing their share to help control pests. It is the occasional firm or individual who usually deliberately places on the market products which are useless or of but little value, who makes necessary the regulation of the insecticide business.

By keeping closely in touch with the channels of advertisement and by watching for new products on the market and promptly investigating them, the Station Entomologist, by cooperating with the Federal Departments, can keep the farmer advised as to the products which he should use in his insect control work.

MR. C. R. CROSBY: There are a number of us who would like to hear paper No. 6, if it is available.

PRESIDENT R. W. HARNED: It is not customary to have papers read unless the authors are here, but this is a special request. If there is no objection, Mr. Houser will read "The Correlation of European Corn Borer Accumulation with Soil Fertility" by L. L. Huber and C. R. Neiswander.

THE CORRELATION BETWEEN SOIL FERTILITY AND EUROPEAN CORN BORER ACCUMULATION

By L. L. Huber and C. R. Neiswander

Abstract

This paper points out that the degree of infestation of corn by *Pyrausta nubilalis* Hubn., depends in large measure on the stage of development attained by the corn at the period of moth flight. The rate of development of corn is greatly influenced by the fertility of the soil. Other factors being equal, a variation in soil fertility may be expected to indirectly influence the accumulation of the insect.

In this paper it is proposed to show that in as far as soil fertility favorably or unfavorably influences corn development it can be correlated with the rate of accumulation of the corn borer. In the first place, it will be pointed out that any general region which habitually produces late, slow developing or poor corn will have a lower borer population than a region which habitually produces early, rapid developing or good corn and, in the second place, it will be shown that corn in any field, part of a field, or in any local area within a region highly favorable to accumulation may have a less than normal borer population by reason of the fact that the condition of corn at the period of moth flight influences the biotic potential.

On the basis of soil origin, Ohio may be divided into two general regions. (1) "Practically all of the country west of a line drawn through Sandusky, Columbus and the eastern part of Adams County is underlain with limestone." (2) "While some limestones are found in the eastern half of the state, the formations consist mainly of sandstones and shales."

It is an obvious fact that western Ohio soils of limestone origin grow more acres of corn per unit of area than the eastern Ohio soils, the parent material of which is non-calcareous. Statistics show that the acreage of corn produced in 37 northern Ohio counties lying within the two areas is in a relative ratio of 100 to 42. Moreover in this connection it is also a fact of long observation that corn grown in western Ohio is planted earlier, grows more luxuriantly, and develops more rapidly than corn grown in eastern Ohio. It is generally agreed too that the difference in the rate of development of corn in the two areas up to the period of moth flight is largely due to the inherent differences in the soil fertility of the two regions, although it is recognized that the extreme northeastern counties are practically outside the corn belt from the standpoint of climate. There is, therefore, sufficient evidence to warrant a correlation between corn development and soil fertility.

Since the beginning of corn borer investigations in Ohio the writers have studied the behavior of the insect in relation to the development of corn as indicated by the rate of growth and the time of tasseling or silking. Evidence indicates that the nature of the response of the corn borer adults to corn depends to a very great degree upon the condition of the corn or the stage of development attained by the plants at the time the moths are in flight. It follows then that any condition which influences the development of corn will indirectly influence the degree of infestation by the corn borer. Therefore, in as far as soil fertility, used in its widest sense, influences the luxuriant growth and rapid development of corn, it also indirectly influences the accumulation of the insect.

The evidence supporting the foregoing statement seems rather conclusive. Over large areas, such as western Ohio and eastern Ohio, data relative to the present infestation as reported by Federal investigators and as collected by the writers indicate that the ratio of borers per given unit of stalks in western Ohio as compared with eastern Ohio is about three to one. Moreover, within a highly susceptible area where corn is generally of good or excellent quality there are fields or parts of fields of corn which have but few borers. Further evidence to support former conclusions was furnished this year by Dr. G. W. Conrey in charge of soil survey work for the Ohio Station in cooperation with the Bureau of Soils, U. S. Department of Agriculture. For example, one field showed a 12 per cent infestation on the light colored soil, 37 per cent on the gradation soil, and 86 per cent on the dark soil.

Four years of data bearing upon the relationship of soil fertility to corn borer accumulation point, therefore, to the fact that the rate of accumulation has been greater in western Ohio than in eastern Ohio. This more rapid rate of increase is believed to be due in large measure to a difference in the development of corn in the two areas at the period of moth flight, which difference in turn is due to variations in soil fertility.

Vice-President J. H. Montgomery assumed the Chair.

Vice-President J. H. Montgomery: Is there any discussion of this paper?

Mr. E. W. Berger: I would like to ask a question. Isn't the more vigorously growing corn more attractive? Is there an odor there that is perhaps insusceptible to humans that draws the moths to lay the eggs in abundance thereon?

Mr. J. S. Houser: It is a known fact the more mature corn is, the greater will be the number of eggs laid on that particular plot of corn. From the studies of moth flight, if you will go into a field of corn where there are areas of well developed corn and areas of poorly developed corn, you will find in the night time the moths hover over the areas of well developed corn, and seemingly avoid the areas of only imperfectly developed corn. The number of eggs laid is likewise opposite on the two areas. Fewer eggs are laid on the poorly developed corn and more on the highly developed corn.

Just what that attraction is the plant physiologists, chemists and entomologists working together have not yet been able to determine. We have used the old photometer experiments and various other ways to try to determine that point. That is one of the basic points on which we need further investigations.

Mr. P. A. Glenn: The supposition that more eggs will be laid on the mature corn than corn that is less mature, I take it, must be based upon the supposition that the moths have a choice; that is, where there is in the same locality corn in the different stages of development. If, in the same locality, all the corn is in the same stage of development and there is no choice for the moth, what will happen? Will it lay its eggs or not?

Mr. J. S. Houser: That, of course, is something no one has yet been able to determine, because we haven't any areas where all the corn has been very, very late and very immature at the time of moth flight. However, there are other factors that enter into it that might well be considered. One is the physical factor, as for example, the size of the plant. A certain percentage of the corn borer larvae spin down from the leaf. If the plant is large and vigorous, it affords a larger surface upon which the larvae may lodge than if the plant is small and immature. So you have at least this one physical factor which we think has some bearing on the point you have raised. If all the corn was very small when the eggs were laid, you would have many more larvae lost in the process of establishment than if all the corn was large.

Mr. J. J. Davis: I might say that Mr. Ficht in his olfactometer tests finds small corn not attractive to the moth.

Mr. P. A. Glenn: Won't they lay their eggs?

Mr. J. J. Davis: They are not attracted to the small corn, while they are attracted to the larger corn.

Mr. P. A. Glenn: There comes in the subject of choice.

VICE-PRESIDENT J. H. MONTGOMERY: The next paper is by H. L. Dozier.

FISH OIL AS AN ADHESIVE IN CONTROL OF THE GRAPE BERRY AND CODLING MOTHS

By H. L. DOZIER, *Entomologist, Delaware Agricultural Experiment Station, Newark, Del.*

ABSTRACT

A brief report is given on preliminary work with fish oil as a sticker of lead arsenate used with Bordeaux mixture and dry lime-sulphur. Great possibilities are indicated for its use in the early pre- and after-blossom sprays in controlling the Grape Berry Moth and in the calyx and first cover sprays on late apples in control of the Codling Moth. On account of its sticking the lead arsenate on the fruit for such long periods caution is given against using it in the later sprays

During the season of 1927 the Codling Moth continued to be the major pest of the apple in Delaware and the Grape Berry Moth increased and spread rapidly in many vineyards.

By far the majority of the damage to apples from the Codling Moth in Delaware comes toward the end of the season and is caused by worms of the second and partial third broods. A certain percentage of this late "stinging" of fruit is due to young worms of the late Oriental Peach Moth broods but the writer's observations so far indicate only a very small proportion in Delaware. To avoid an annual repetition of this late "stinging" every effort should be made to effect a clean-up of over-wintering worms in packing houses and old picking baskets, under rough bark, etc. and by doing a thorough consistent spray job under personal supervision. A complete control of the first brood of worms will leave few to reach the adult stage to reproduce themselves at that part of the season when conditions have become most favorable to their rapid development. It has been the writer's personal observation that most of the damage to late apples in Delaware is due to the fact that the apples are not sufficiently protected by a cover spray at the time when the young worms of the second generation are hatching. This comes just at the time when every grower is picking, packing or marketing his early apple crop and especially is this true when a long drawn out cold spring occurs with its consequent delayed emergence, deposition and hatching. There can be no question that the large interplantings of late, mid-summer, and early varieties of apples with their different blooming and maturation periods constitutes a severe handicap to the Delaware growers in the problem of Codling Moth control.

At this moment when there is so much agitation against spray residue our problem becomes even more complicated and the question is "how late can we spray safely?" and the answer comes back "avoid the necessity of late cover sprays by completely controlling the first brood. Even where every reasonable effort is concentrated, however, there will be enough of the first brood worms to escape and come through generally to produce a large amount of wormy late fruit in cases where the initial carry-over infestation is heavy. No single year, even of the most energetic and intensive kind of clean-up and spraying, is going to eliminate entirely the Codling Moth and at least three seasons will probably be necessary to bring it down to within practical limits.

Why not attack this problem by putting on an application of lead arsenate just before the early apple harvest starts that will stick through that vital period without leaving too much residue on the late apples at picking? With this idea in view the writer introduced two stickers this summer in Delaware that appear promising, "Fluxit "a new type of spreader that is manufactured on the Pacific Coast and a "Choice light pressed" Menhaden fish oil. The latter has been used for several years successfully as a sticker with plain lead arsenate on forest trees in Massachusetts in Gypsy Moth work and is reported on in U. S. Dept. of Agriculture Bulletin 1439 by C. E. Hood. The writer is now attempting to work out its practical application and place in our orchard and vineyard programs. Preliminary tests on apple and grape show it to be very promising as a cheap and efficient adhesive for lead arsenate in the earlier sprays. It sticks the spray on the foliage and fruit for such long periods, however, that it can be recommended with safety only for the early applications and much work must be done along that line. Indiscriminate use of fish oil would most certainly ruin the market for our apples.

The material used was that recommended by Hood with the following specifications:—

Saponification value	190 to 193
Iodine value	139 to 193
Specific gravity at 15 C.	0.927 to 0.933
Free fatty acid	Less than 5 per cent

Indications are that the darker, cheaper grades with high free fatty acid content do not give good results.

The material was supplied to the growers, due to pressure of other problems, and they applied it themselves. The spray applications and results were checked by the writer.

On June 17th a row of twenty large fifteen-year old Rome Beauty trees in the orchard of J. Leonard Soper at Magnolia, Del. was sprayed with plain lead arsenate at the rate of two pounds to fifty, with a quart of the fish oil added to the 200 gallon tank. At time of the first picking September 8th these apples showed residue and were carefully brushed. The fruit with the one application was as free from worms and as nice in appearance as adjacent fruit sprayed three times with lead arsenate, lime and caseinate spreader. The owner was so enthusiastic that he plans on trying it on several hundred acres next season.

On June 13th fish oil was used at the rate of 1½ qts. to the 200 gallon tank in combination with 2-6-50 Bordeaux and Sherwin-Williams Dry Lime-sulphur on a block in the orchard of H. E. Coverdale near Dover, Delaware. Two months later, after periods of heavy rains, traces were still present on the foliage and fruit. It seemed to work better with the Bordeaux mixture than with the Dry Lime-sulphur.

At the orchard of Frank C. Bancroft near Camden, Del. a mixed block of 400 King David and Stayman trees was sprayed July 12th with 2-6-50 Bordeaux and two pounds of lead arsenate to fifty. The southwestern half of the trees was sprayed with one pint of fish oil added to each 100 gallons of spray and the remaining half of the trees was sprayed with one pound of calcium caseinate added to each 100 gals. On examination of these trees on August 10th it was quite evident that the fish oil was far superior to the calcium caseinate as a sticker. Three carloads of the earlier King David picked August 25th for export had to be very carefully run through brushes and wiped. The last car of King David was picked September 20th. The Staymans from this block were picked October 1st and by this time were practically free from any residue.

The "Fluxit" sticker and spreader was used in the apple orchard of H. E. Coverdale with 2-6-50 Bordeaux July 21st and with Sherwin-Williams dry lime-sulphur July 26th at the rate of two pounds to the 200 gallon tank. This block of 300 Stayman and Nero trees was sprayed again on Aug.8-9th using the "Fluxit" with the Sherwin-Williams dry lime-sulphur. Considerable spray residue was showing when this fruit was picked on October 15th. Most of this fruit, due to scab and bad russeting, was sold to a canning factory.

Fish oil also has great possibilities in the control of the Grape Berry Moth which has become the most serious problem of the grape grower in this section during the past two years. The newly hatching worms of the first spring brood were just starting to enter the young berries this season on June 23rd in the seven-acre vineyard of Nat. W. Taylor near Lebanon, Del. This demonstrated clearly the necessity of including lead arsenate in the pre-blossom spray which had been applied ten days previous. By July 1st "stung" berries were so abundant that a total loss threatened and the owner applied a spray of 4-6-50 Bordeaux, five pounds of lead arsenate to fifty, and added a quart of fish oil as a sticker to each 100 gallons. This was applied July 1st by the trailer method under pressure of 350 pounds and was done in a very thorough manner—the opposite of the preceding pre- and after-blossom sprays By July 28th no worms could be found in the vineyard but on August 24th the second brood worm injury was starting—the young worms being only a quarter of an inch in length and apparently only three or four days old. A check up made on August 30th showed the spray to be very effective while on other properties examined, as high as 50% of the berries were wormy on this date. In the Taylor vineyard a nice crop was cut while on some of the other properties almost a total loss and further spread occurred.

There can be no question as to the effectiveness of the "choice light pressed" fish oil as a sticker. So well did the Bordeaux-arsenate of lead-fish oil spray adhere to the clusters of grapes that it was thought until September 10th that they would have to be dipped. By the time of cutting on the 18th of September there was still a trace of residue left but not sufficient to necessitate dipping.

The writer believes that the fish oil shows great possibilities in control of the Grape Berry Moth when used in the pre- and after-blossom sprays but if used after June 15th there will be danger of having too much spray residue at cutting time.

In the apple spray program indications are that it can be used to advantage in the calyx and first cover sprays on the late varieties but until further tests are made it should not be used on the early varieties other than the calyx application. It is decidedly cheaper than the caseinate spreaders, makes the spray adhere longer, and makes possible less frequent spraying.

SECRETARY C. W. COLLINS: We at the Gipsy Moth Laboratory are rather pleased to know that fish oil is being tried as an adhesive in Deciduous Fruit Insect Investigations. I especially want to call your attention to photographs we have in the exhibit hall of fish oil in Arsenate of Lead Spray for leaf feeding forest insects. A spray of 3⅓ pounds of arsenate of lead powder to 100 gallons of water and 4 ounces of fish oil

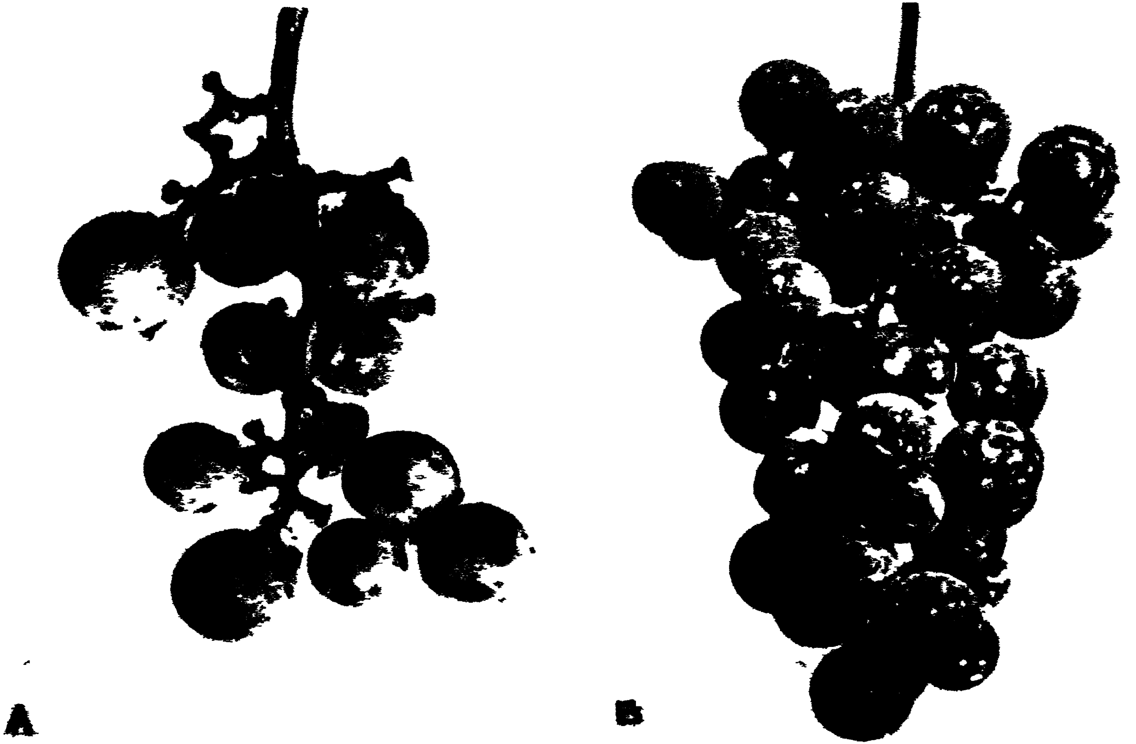

PLATE 2 A Unprotected grape cluster showing typical shattering caused by second brood Grape Berry Moth Sept 2 1927 *B* Representative cluster from Taylor vineyard thoroughly sprayed with 4-6-50 Bordeaux with 5 lbs of lead arsenate and 1 pint of fish oil added to each 50 gallons Application made July 1 1927 and cluster photographed August 27 1927 after a period of heavy rains

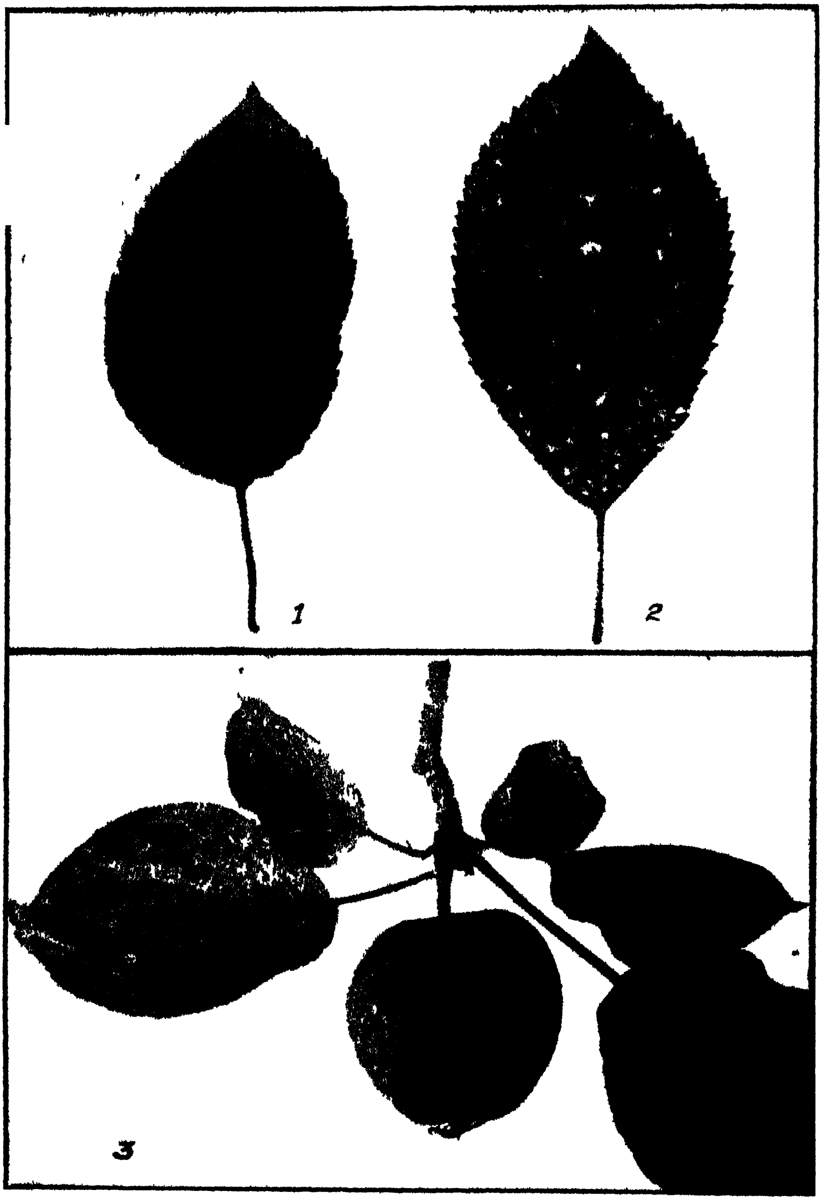

PLATE 3.—Apple leaves and fruit from the Coverdale orchard, sprayed June 13, 1927 with 1½ quarts of fish oil and 8 lbs. of lead arsenate added to the 200 gal. tank. Photographed June 28, 1927, following very heavy rains, slightly reduced. 1. Sprayed with Sherwin-Williams dry lime sulphur, 2. With 2-6-50 Bordeaux mixture, 3. With Sherwin-Williams dry lime sulphur.

per pound of arsenate of lead added was applied to acre plots of forest trees and 5,500 gipsy moth larvae were killed and collected on a mat, or a rate of 1,661,000 larvae killed per acre. Experiments shows that an average of 63 per cent of the poison was still on the foliage after eight inches of rain. We think those tests showed striking results.

MR. H. L. DOZIER: Don't you think it has a very good application in orchard work?

SECRETARY C. W. COLLINS: We are not prepared to say. We have not made any tests with orchard insects. Our work is with forest and shade tree insects, but we do think, however, there are great possibilities with fish oil along those lines.

VICE-PRESIDENT J. H. MONTGOMERY: The next paper is by Messrs. Hartzell and Wilcoxon.

ANALYSES OF SPRAYED APPLES FOR LEAD AND ARSENIC

By ALBERT HARTZELL and FRANK WILCOXON,
Boyce Thompson Institute for Plant Research, Inc., Yonkers, N. Y.

ABSTRACT

In continuation of work on arsenical residues, apples grown at Yonkers, New York, that had received the standard spray schedule comprising 5 applications of lead arsenate (4 lbs. to 150 gals.), during the season of 1927, showed on analysis an average of 0.912 mg. of metallic lead per kg. of fruit and a maximum of 1.80 mg. per kg. The arsenic trioxide found in the samples averaged 0.099 mg. per kg. of fruit with a maximum of 0.193 mg. per kg., this maximum being considerably below the limit adopted by the Royal Commission on Arsenical Poisoning in 1903 (1.429 mg. per kg.). There were 33.24 inches of rainfall from the time the first spray was applied until the date the fruit was picked.

INTRODUCTION

During the season of 1927, in continuation of work on arsenical residues (1), apples grown at Yonkers, New York, that had received the standard 5-spray schedule (4 lbs. lead arsenate to 150 gals.) were analyzed for lead and arsenic. Lead arsenate is a doubly dangerous poison because in addition to arsenic it also contains lead which is a cumulative poison. Since very few determinations of lead spray residues have been published, it was thought of interest to include analyses for both lead and arsenic in this paper.

Woods (2) analyzed washings of apples that were sprayed with lead arsenate in August and picked two months later. An average of 1.09 mg. of metallic lead per kg. of fruit is indicated by his analyses. Attention is called by him to the fact that lead arsenate calculated from the arsenic found in his samples was about one and one-half times that calculated from the lead, but no explanation of this discrepancy is offered. He concludes that the amount of arsenic or lead that will remain at harvest time upon fruit sprayed as late as mid-summer is so slight as to be of no practical importance.

Sonntag (3) found apples sprayed with lead arsenate to contain from 7.5 mg. per kg. to 34 mg. per kg. of lead, 24 days after spraying, while 80 days after the spray application, there remained 0.17 to 0.57 mg. per kg.

Lynch, McDonnell, Haywood, Quaintance and Waite (4) give the results of a large number of determinations of lead from sprayed fruit, and find sprayed apples to contain from 0.036 to 2.80 mg. per kg.

Analyses of apples from the United States and British Columbia reported by Sir R. Robertson, Government Chemist, Great Britain (5), show metallic lead ranging from 0.0001 to 0.0057 grains per pound of fruit (0.014 to 0.814 mg. per kg.). It is stated that about 16 pounds of apples containing lead at this rate would have to be consumed, including peel, stem and calyx, before a minimum pharmacopoeial dose of lead would be taken.

Recent determinations of arsenical residues on apples have been published by Cox (6), who found 0.5 to 15.0 mg. of arsenic trioxide per kg. In one case of suspected poisoning, the author found the apples to contain 8 mg. per kg. of arsenic trioxide and 28 mg. per kg. of lead. He further states that the arsenic is not entirely confined to the skin and gives values obtained from two determinations on apples heavily sprayed in the laboratory, and analyzed 48 hours later, as follows: 3.3 and 1.3 mg. per kg. in the flesh, while the whole apples contained 24 and 7 mg. per kg. respectively.

Shutt (7) examined a large number of Canadian sprayed apples for arsenic and the largest amount found was 0.742 mg. per kg.

The matter of arsenical residues on imported apples has been the subject of a question (8) in the British Parliament.

MacLeod, Haley and Sudds (9) reporting on the results of analyses of 42 samples of apples from a number of localities in Pennsylvania give determinations ranging from a trace to 0.843 mg. per kg. of fruit. They state that the amount of visible spray residue was not an adequate indication of the quantity of arsenic on the fruit.

PLAN OF EXPERIMENT

In order that the results would be comparable from year to year the plan of the experiment as stated in a previous publication (1) was followed as far as practical in every detail. Four pounds of Grasselli powdered lead arsenate,[1] two pounds of calcium caseinate and 1½ pints of nicotine sulfate to 150 gallons of spray solution were used in all applications. The sprays were applied on the following dates: delayed dormant, April 18; blossom pink, May 2; calyx, May 18; two weeks, June 3; mid-summer, July 12. Lime-sulfur at regular strengths was used in the first four applications but was omitted from the last as scab infestation was very light. The sprays gave 96% control of codling moth which was the principal insect trouble. On September 14, 100 apples were picked from the lower branches of the sprayed trees for analysis, care being taken in handling not to remove the spray residue. To inhibit respiration, the apples were placed in cold storage at 5°C. until ready to be prepared for analysis.

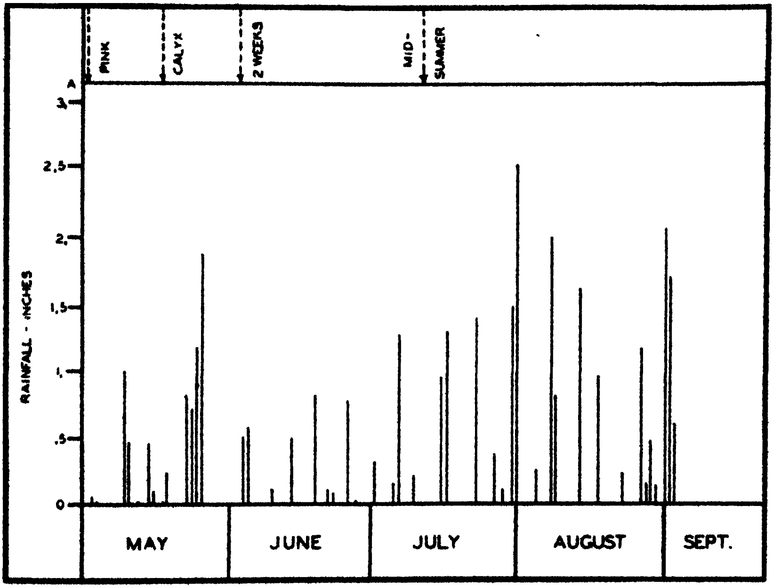

FIG. 4. Graph showing dates of spraying, daily precipitation and time of sampling. Horizontal line A indicates the length of time the apples remained on the trees.

CLIMATIC FACTORS

The rainfall at Yonkers, New York, during the season of 1927 was unusually heavy. From the time of the first spray application, (the delayed dormant), which was made on April 18, until September 14, the date when the apples were picked, 33.24 inches of rain fell. The daily precipitation, dates of spraying and the length of time the apples remained on the trees are shown graphically in Fig. 4. The heavy rainfall this season must be considered in making comparisons of lead and arsenic content of fruit. The results are probably somewhat lower than would be expected for a season of normal precipitation.

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[1] A sample of lead arsenate used in this experiment was found on analysis to contain 64.02% of lead calculated as PbO and 33.1% of arsenic calculated as As_2O_5.

METHOD OF ANALYSIS

Lead was determined colorimetrically as the sulfide, while the Gutzeit method was used for arsenic. Four apples were used for a single determination. The peel, stem and calyx were removed from samples 1 to 12 inclusive, the organic material destroyed by digestion with sulfuric and nitric acids. Samples 13–20 were scrubbed with 2% sodium hydroxide solution, using a brush to remove as much spray residue as possible. MacLeod, Haley and Sudds (9) reported satisfactory results obtained by using ammonium hydroxide to remove the spray residue for analysis. The lead was separated as sulfate, dissolved in hot ammonium acetate solution, and the determination of lead made as described by Lynch, McDonnell, Haywood, Quaintance and Waite (4). The sensitized paper for the arsenic determinations was prepared as suggested by Kemmerer and Schrenk (10). Blank determinations were made on the reagents and on the reagents with peel from apples known to have never received lead or arsenic sprays. In both cases insignificant amounts of lead and arsenic were found.

RESULTS

The results of the determinations were calculated to mg. of metallic lead and mg. of arsenic trioxide per kg. of fruit and are given in Table 1.

The average value for lead and for arsenic in samples 1 to 12, where the material was digested with sulfuric and nitric acids, is considerably higher than the value found for samples 13–20, where the surface of the apples was scrubbed with sodium hydroxide solution. It appears probable that the latter procedure resulted in incomplete removal of the spray residue.

In all cases the ratio of lead to arsenic is higher than that to be expected from the composition of the lead arsenate used. This suggests that the action of atmospheric agencies brings about a gradual decomposition of the lead arsenate on the fruit, which results in more arsenic than lead being dissolved and washed away. McDonnell and Graham (11) have shown that such a decomposition is in fact brought about by long continued washing with distilled water, while Mogendorff (12), Campbell (13), and Ginsburg (14, 15) have shown that the presence of lime, lime-sulfur, and calcium caseinate spreaders may lead to the formation of soluble arsenic in considerable amounts. Recently P. A. van der Meulen and E. R. van Leeuwen (16) have studied the action of calcium hydroxide on acid lead arsenate in the laboratory, and have determined the extent and the rate of decomposition under definite conditions. The high arsenic values obtained by Woods (2) may perhaps be explained by this circumstance, since he analyzed washings from sprayed apples and not the apples themselves.

TABLE 1. ANALYSES FOR LEAD AND ARSENIC REMAINING ON APPLES AT PICKING TIME

Sample No.	Wt. Grams	Mg. Pb per kg. Fruit	Mg. As_2O_3 per kg. Fruit
1	479	1.35	0.042
2	403	1.36	0.074
3	367	1.77	0.136
4	363	1.23	0.055
5	483	1.55	0.145
6	424	1.06	0.047
7	502	0.69	0.119
8	415	0.60	0.120
9	404	0.86	0.148
10	362	1.80	0.193
11	444	1.69	0.113
12	425	0.82	0.118
13	421	0.59	0.095
14	446	0.78	0.101
15	374	0.40	0.093
16	301	0.50	0.133
17	435	0.57	0.069
18	450	0.155	0.055
19	369	0.27	0.054
20	337	0.21	0.089

CONCLUSION

Comparing the results obtained this season with those of 1926, it was found that in 1926 the average amount of arsenic as As_9O_3 was 0.173 mg. per kg. of fruit, with a rainfall of 17.85–19.51 inches, while in 1927 the average value was 0.099 mg. per kg. with a rainfall of 33.24 inches. No sample analyzed in either year exceeded the limit adopted by the Royal Commission on Arsenical Poisoning in 1903 (17). The ratio of lead to arsenic found this season was considerably higher than that to be expected from the composition of the lead arsenate used.

due to three important factors. First, the abnormal life cycle of the codling moth; second, the spray residue situation and third, the activities of the salesmen of dusting chemicals and dusting machines.

So far we have tried to emphasize the fact that the dusts are still largely in the experimental stage and as yet it would be exceedingly unwise to discard the liquid sprays in favor of the dusts. However, where a fruit grower has insisted on using the dusts we have recommended that they be used only as a supplement to the liquid sprays. Our three years experimental work with the dust has substantiated these recommendations, especially when we take into consideration the cost of chemicals.

RESULTS IN 1925

Two important conclusions may be deduced from the results obtained in 1925. First, that in order to obtain as good results with the dusts

TABULATION OF RESULTS 1926

Plot	Material and Strength	Lbs. per tree	No. of applications	Cost of materials per acre	Efficiency for all insects and diseaess	% curculio	Codling Moth		Brown rot	Scab
							Calyx	Side		
I	Liquid L. S. and Lead		3	13.00	3rd	48.73	.6	21.13	2.86	.1
II	90–10 Sulphur-lead	2	3	14.10	6th	73.	.3	26.3	3.8	1.4
III	90–10 Sulphur-lead	2	8	37.60	1st	46.8	0	14.8	3.0	.3
IV	(a) 2 liquids[1] 1 90-10 dust	2	3	13.36	5th	53.9	0	12.8	15.0	0
V	(b) 2 liquids[2] 1 90–10 dust	2	3	13.36	2nd	45.8	.4	14.2	2.4	.2
VI	80–10–8 Lime-copper-Lead	2	3	9.12	7th	88.8	.7	28.4	10.6	0
VII	80–10–8 Lime-copper-Lead	2	8	24.32	9th	92.8	4.	48.3	14.9	1.1
VIII	(c) 2 liquids[3] 1 80–10–8 copper	2	3	11.70	8th	77.4	12.8	49.	3.9	0
IX	(d) 2 liquids[4] 1 80–10–8 copper	2	3	11.70	4th	52.9	.8	24.5	.9	.1

[1] The calyx spray was a 90–10 dust.

[2] The third or curculio spray was a 90–10 dust.

[3] The Calyx spray was a copper dust.

[4] The third or curculio spray was a copper dust.

as with the liquid spray about twice as many applications of the dusts must be made as with the liquid. Second, that two pounds of dust per tree will give practically as good results as five pounds per tree.

Results in 1926

In 1926 both the sulphur and the copper dusts were used in a supplemental way with the liquids. They were also used straight.

In general the results obtained in 1926 were the same as those obtained in 1925. The copper dust used was a home made mixture and the results obtained from its use were very poor. Very good results were obtained with the dust as a supplement to the liquid sprays but where it was necessary to make at least twice as many applications as with the liquid in order to obtain the same results.

Results in 1927

The season of 1927 was very wet which made it difficult to make the necessary application.

Plot	Materials and Strength	Lbs. per tree	No. of applications	Cost of materials per acre	Efficiency for all insects and diseases	% curculio	Codling Moth		Brown rot	Blotch	Scab
							Calyx	Side			
I	90-10 sulphur-lead	2	6	$28.20	3rd	35.69	5.42	33.95	2.7	.55	2.83
II	Copper dust	2	6	38.88	1st	25.53	5.51	27.06	2.64	.66	.79
III	Liquid L. S. & lead		6	25.98	2nd	33.2	4.89	30.53	2.05	.48	.14
IV	[1]Liquid L. S. & lead 90-10 dust	2	7	36.49	4th	28.47	8.81	39.46	1.86	1.2	.12

[1] First three sprays liquid.
All cover sprays dust.

Home made copper dust gave such poor results in 1925 and 1926 that it was discarded in 1927. However, a proprietary copper dust was used on a plot in 1927, and it is interesting to note that this dust gave the best results of all the mixtures used. This dust, however, is expensive. Other than the copper dust the results obtained in 1927 were similar to those obtained in 1925 and 1926.

SUMMARY

A general summary of the three year's work under conditions in Missouri seem to indicate the following:

(1) The cost of the dust sprays are greater than the liquid. There is some saving, however, in the labor in favor of the dusts.

(2) In order to obtain results with the dusts comparable to those obtained with the liquids it is necessary to make about twice as many applications with the dusts as with the liquids. This is undoubtedly due to the fact that the dust will not remain on the foliage as long a period as will the liquid sprays.

(3) The home made copper dust failed to give satisfactory results. A commercial copper dust gave promising results.

(4) In general the dusts failed to control the apple diseases as well as the liquids, however, the apple diseases were not serious in the experimental orchard in which the dusts were used.

GENERAL CONCLUSIONS which have been arrived at from the three year's work are:

(1) It would be exceedingly unwise for the Missouri commercial apple grower to discard the liquid sprays and in place of them substitute the dusts.

(2) The dusts may be used as a supplement to the liquid sprays which will result in the saving of considerable labor. Under present conditions with the codling moth showing such variation in its life cycle the large grower might economically employ the dusts as a supplement to the liquids.

(3) Without question the dusts which are used at the present time will not adhere to the fruit and foliage for any great length of time. In case the dusts are used for the late summer sprays the spray residue problem will be practically eliminated.

VICE-PRESIDENT J. H. MONTGOMERY: The next paper is by H. J. Grady.

RECENT DEVELOPMENTS IN PEAR PSYLLA CONTROL

By H. J. GRADY, *Augusta, Kansas*

(Withdrawn for publication elsewhere)

VICE-PRESIDENT J. H. MONTGOMERY: The next paper is by R. H. Carter and R. C. Roark.

COMPOSITION OF FLUORIDES AND FLUOSILICATES SOLD AS INSECTICIDES

By R. H. CARTER and R. C. ROARK, *Washington, D. C.*

(Withdrawn for publication elsewhere)

VICE-PRESIDENT J. H. MONTGOMERY: The next paper is by R. C. Roark and R. T. Cotton.

FUMIGATION TESTS WITH CERTAIN ALIPHATIC CHLORIDES

By R. C. ROARK, *Bureau of Chemistry and Soils*, and R. T. COTTON, *Bureau of Entomology, Washington, D. C.*

ABSTRACT

Twenty-one aliphatic chlorides were tested against rice weevils in flasks half filled with wheat. The more promising of these fumigants were also tried against larvae of the clothes moth, black carpet beetles, and furniture beetles in a 500 cubic foot fumigating vault.

None of these materials injured the germination of wheat, and several appear promising as cheap, effective fumigants of low fire hazard.

INTRODUCTION

In the search for materials of low fire hazard that may be used in place of carbon disulfide for fumigating insects in stored products the chlorine substitution products of the lower aliphatic hydrocarbons naturally suggest themselves. Many of these chlorides are commercially available; they are cheap; although none of those previously tested showed much toxicity to insects, they are not toxic to man, they are not readily inflammable, they possess pleasant odors, and they do not bleach fabrics or corrode metals. For these reasons we have considered it worth while to re-examine some of the aliphatic chlorides previously examined, as well as to test additional ones.

PREVIOUS WORK

Methylene chloride was tested by Neifert, et al, (11) against the rice weevil and flour beetle. The minimum lethal dose of this fumigant was about 10 pounds per 1,000 cubic feet.

Chloroform in previous tests (11) killed the flour weevil at a dosage of about 11 pounds per 1,000 cubic feet, but about 23 pounds were required to kill the rice weevil and the granary weevil, and as much as 46 pounds was required to kill larvae of the Indian meal moth. Chloroform has been tested against a variety of insects by Tattersfield and Roberts (16); Richardson and Smith (13); Moore (10); Holt (6); Trillat and Legendre (18); Bertrand and Rosenblatt (2); Lefroy (17); McClintock, Hamilton and Lowe (9); Titschack (17); and many others, but all report that it has a low toxicity.

Carbon tetrachloride is well known as a fumigant, but is considered to have low toxicity.

Ethylidene chloride was found to give a perfect kill at 28 pounds per 1,000 cubic feet, (11).

Ethylene chloride (ethylene dichloride) has recently been tested by Cotton and Roark (3) who found it to be a promising fumigant for household purposes and for use in fumigating vaults. Apparently this material has escaped the attention of other investigators as we can find no reference to its use as an insecticide other than our previous work.

Ethylene chlorobromide has not been tested for its toxicity to insects.

Trichloroethane (the technical article, which is largely 1, 1, 2-trichlorethane) in previous tests Neifert, et al (11), killed rice weevils at a concentration of 3 pounds per 1,000 cubic feet. Apparently no others have tested this material.

Tetrachloroethane (the commercial article is symmetrical or 1, 1, 2, 2-tetrachloroethane) has received considerable attention as a fumigant in England. Tattersfield and Roberts (16); Parker and Long (12), Altson (1), Lloyd (8), and Speyer (15) have reported results with it. Previous work by Neifert, et al (11) indicated that at least 5 pounds per 1,000 cubic feet were required to kill weevils in bell jars.

Parker and Long (12) reported that pentachloroethane is more toxic to the larvae of *Trogoderma khapra* Arrow than is tetrachloroethane.

Hexachloroethane has been suggested for use against moths in place of naphthalene and paradichlorobenzene by Smits Van Burgst (14) and Dingler (4); it has been tested as a soil fumigant by Fleming (5).

Isopropyl chloride and propylene dichloride (1, 2-dichloropropane) were tested by us in our previous work (11).

Dichloroethylene (acetylene dichloride) has been tested by Tattersfield and Roberts (16) and by Neifert, et al (11).

Trichloroethylene has been tested by Tattersfield and Roberts (16); Parker and Long (12); and Neifert, et al (11).

Tetrachloroethylene has apparently been previously tested only by Neifert, et al (11).

The following compounds, tests with which are herewith reported; have apparently never been previously tested for their insecticidal action: ethylene chlorobromide, n-propyl chloride, 1, 3-dichloropropane, n-butyl chloride, tert. -butyl chloride, 1, 1-dichlorobutane, and isoamyl chloride.

EXPERIMENTAL

In our experimental work a series of tests was made on weevils in half-liter glass flasks; and another series of tests was made on various insects in a 500 cubic feet fumigating vault.

For the tests on a small scale rice weevils (*Sitophilus oryza* L.) were used on account of their recognized resistance to fumigants.

Vials each containing 10 weevils and some cracked corn and stoppered with a plug of cotton, were placed in 500 cc Erlenmeyer flasks and covered with 250 cc (approximately 200 grams) of wheat. As a rule, 1 vial was placed in a flask, but in some cases 2 vials were used. The calculated quantity of fumigant was added by means of a Mohr pipette graduated to 0.01 cc. The flasks were then tightly stoppered with

TABLE 1. MINIMUM LETHAL CONCENTRATION IN MILLIGRAMS PER LITER OF THE VAPORS OF VARIOUS ALIPHATIC CHLORIDES TO THE RICE WEEVIL FOR 24 HOURS EXPOSURE AT ROOM TEMPERATURE (21 TO 27°C.) IN THE PRESENCE OF WHEAT

Compound	Formula	Mol. Wt.	Boiling point	Specific gravity	Min. lethal conc. Mg./L.
Methylene chloride	CH_2Cl_2	84.931	40.1	1.336	428
Chloroform	$CHCl_3$	119.38	61.2	1.489	298
Carbon tetrachloride	CCl_4	153.83	76.8	1.595	638 ✓
Ethylene chlorobromide	$CH_2Br\text{-}CH_2Cl$	143.405	103.7	1.79	143
Ethylidene chloride	$CH_3\text{-}CHCl_2$	98.947	57.3	1.174	564
Ethylene dichloride	$CH_2Cl\text{-}CH_2Cl$	98.947	83.7	1.257	226 ✓
Trichloroethane (tech.)	$C_2H_3Cl_3$	133.397	113.5[1]	1.443	404
s-Tetrachloroethane	$CHCl_2\text{-}CHCl_2$	167.85	146.3	1.600	384
Pentachloroethane	$CHCl_2\text{-}CCl_3$	202.298	162	1.709	342
Hexachloroethane	$CCl_3\text{-}CCl_3$	236.75	185	2.091	—
n-Propyl chloride	$CH_3\text{-}CH_2\text{-}CH_2Cl$	78.512	46.6	.890	445
Isopropyl chloride	$CH_3\text{-}CHCl\text{-}CH_3$	78.512	36.5	.860	430
Propylene dichloride	$CH_3\text{-}CHCl\text{-}CH_2Cl$	112.962	96.8	1.166	140 ✓
1, 3-Dichloropropane	$CH_2Cl\text{-}CH_2\text{-}CH_2Cl$	112.962	125	1.201	336
n-Butyl chloride	$CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2Cl$	92.527	78	.884	265
tert.-Butyl chloride	$(CH_3)_3CCl$	92.527	51	.840	34 ✓
1, 1-Dichlorobutane	$CHCl_2\text{-}CH_2\text{-}CH_2\text{-}CH_3$	126.976	113–115	1.1	220
Isoamyl chloride	$(CH_3)_2CH\text{-}CH_2\text{-}CH_2Cl$	106.54	99.1	.893	107
Dichloroethylene	$CHCl = CHCl$	96.946	55[2]	1.25	600
Trichloroethylene	$CHCl = CCl_2$	131.38	88	1.477	650
Tetrachloroethylene	$CCl_2 = CCl_2$	165.83	120.8	1.623	649

[1] Boiling point of 1, 1, 2, trichloroethane, the major constituent of the technical article.

[2] Boiling point of commercial article which consists of a mixture of cis-1, 2-Acetylene dichloride, boiling point 48.4, and tran-1, 2-Acetylene dichloride boiling point 60.3.

rubber stoppers, and allowed to stand 24 hours at the temperature of the laboratory (21 to 27°C.). At the end of that time the vials were removed and the percentage of dead weevils determined. The treated weevils were re-examined one week later for possible revivals.

Twenty-one aliphatic chlorides tested in this way gave the results shown in Table 1.

Discussion of Results

Only one of the compounds tested, namely hexachloroethane failed to kill 100 per cent of the weevils at the maximum concentration tested (0.5 gram per liter).

The most effective fumigants, on a laboratory scale and under the conditions of the test are: tertiary butyl chloride, iso amyl chloride, propylene dichloride, ethylene chlorobromide, and ethylene dichloride in the order named.

A report on ethylene dichloride has already been made by the writers (3); propylene dichloride at the present time is quoted at $1.00 per pound and ethylene chlorobromide is not at present obtainable. Large scale tests were therefore confined to tertiary butyl chloride, and two compounds of lower toxicity that are without fire hazard, trichloroethylene and tetrachloroethylene.

The large scale tests were conducted in a commercial type vault of 500 cubic feet capacity. The fumigant was poured through a trap door in the top of the vault into a shallow evaporating trough suspended

TABLE 2

Fumigant used	Dosage per 1000 cu. ft.	Length of exposure	Temp.	Killed		
				Anthrenus vorax	Tineola[1] biselliella	Attagenus piceus
	Pounds	Hours	°F.	Per cent	Per cent	Per cent
Carbon tetrachloride alone	30	24	85	100	100	100
Tetrachloroethylene alone	25	24	85	90	100	100
" "	30	24	85	100	100	100
Trichloroethylene alone	10	24	83	84	80	88
" "	12	24	83	100	100	100
Ethylene dichloride 3 vols. Carbon tetrachloride 1 vol.	6	24	85	100	100	100
" "	12	24	65	100	100	100
Tert. butyl chloride 3 vols. Carbon tetrachloride 7 vols.	10	24	83	40	70	60
" "	12	24	83	100	100	100

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[1] In all tests 20 specimens of the clothes moth larvae and 50 larvae each of the other two species were used.

near the ceiling. The vault was then closed for 24 hours. The insects used in the tests were the larvae of the clothes moth, *Tineola bisselliella*, of the black carpet beetle *Attagenus piceus* and of the furniture beetle *Anthrenus vorax*, species all highly resistant to fumigation. The larvae were placed in cotton-stoppered vials and buried in pieces of overstuffed furniture.

The results obtained are given in Table 2. For the sake of comparison, previously published results with ethylene dichloride and carbon tetrachloride are included.

Since certain of the chlorides tested are inflammable it was deemed advisable to mix them with a sufficient volume of carbon tetrachloride to render them free from fire hazard.

From the data contained in Table 2 it will be seen that in order of toxicity to the insects treated in the vault the compounds rank as follows: Tertiary butyl chloride, ethylene dichloride, trichloroethylene, tetrachloroethylene, and carbon tetrachloride. These results are somewhat at variance with the results obtained in the small scale tests, but may be explained in part by the fact that the fumigations in the vault were not conducted in the presence of wheat as was the case in the laboratory tests. Wheat when fumigated adsorbs a certain quantity of the fumigant and adsorbs a greater quantity of some fumigants than of others.

Trichloroethylene for example proved to be about two and a half times as toxic as tetrachloroethylene and carbon tetrachloride, whereas in the laboratory tests in the presence of wheat the toxicity of all three compounds was practically identical.

Chemically pure compounds were used in the laboratory tests and commercial products were used in the large scale tests.

In the fumigation tests with tertiary butyl chloride in the vault a chemical change took place which resulted in an oily deposit on the sides of the fumigation chamber. The fumigant reacted with the moisture of the atmosphere to form hydrochloric acid which attacked the zinc lining of the vault forming a solution of zinc chloride.

This breaking down of the tertiary butyl chloride reduces its toxicity and renders it unsuitable for use in metal-lined vaults. It should prove of value in non-metal fumigating chambers and since it has no injurious effect upon the germination of wheat it may prove useful as a grain fumigant.

The aliphatic chlorides when used as fumigants have no injurious effect upon the germinating qualities of grain as may be seen from the data contained in Table 3.

TABLE 3. EFFECT OF THE VAPORS OF VARIOUS ALIPHATIC CHLORIDES UPON THE GERMINATION OF WHEAT

Fumigant	Minimum lethal dose grams per kg. wheat	Dose applied	Germination	
			Actual overcheck	Comparative (check = 100)
Methylene chloride	1.1	1.0	79.5/79	101
" "	1.1	1.7	93/92.5	100
Chloroform	.7	1.9	80.5/80	100
Carbon tetrachloride	1.6	.3	91/86.5	105
" "	1.6	.3	90/86.5	104
" "	1.6	3.2	93/86.5	108
Ethylene chlorobromide	.4	.9	76/79	96
Ethylidene chloride	1.4	.9	75.5/79	96
Ethylene dichloride	.5	.6	90.5/86.5	105
" "	.5	.9	79/79	100
Trichloroethane	1.0	1.75	77/79	97
" "	1.0	1.75	76/79	96
s-Tetrachloroethane	1.0	1.2	74/79	94
Pentachloroethane	.9	1.3	83/79	105
Hexachloroethane	—	1.25	94.5/92.5	102
n-Propyl chloride	1.1	1.1	77.5/79	98
Isopropyl chloride	1.1	1.1	80/79	101
Propylene dichloride	.35	.6	91/86.5	105
1, 3-Dichloropropane	.8	1.5	91.5/95	96
n-Butyl chloride	.7	1.1	86/79	109
Tert.-Butyl Chloride	.08	.2	90.5/97.5	93
" "		1.0	91.5/97.5	94
1, 1-Dichlorobutane	.5	1.4	78.5/79	100
Isoamyl chloride	.3	.4	96.5/97.5	99
" "	.3	2.2	94/97.5	96
Dichloroethylene	1.5	1.6	95/92.5	103
Trichloroethylene	1.6	1.8	90/95	95
Tetrachloroethylene	1.3	1.2	77/79	97
" "	1.3	1.6	91.5/86.5	106

CONCLUSION

Of 21 aliphatic chlorides tested, several were found to possess considerable toxicity to stored product insects. From the standpoint of availability, cost, effectiveness and freedom from fire hazard ethylene dichloride in a mixture of 3 volumes of ethylene dichloride to 1 of carbon tetrachloride appears to be the most promising as a general fumigant, tert-Butyl chloride although more toxic than ethylene dichloride requires a larger proportion of carbon tetrachloride to render it free from fire hazard and cannot be used in metal-lined vaults owing to its tendency to break down and attack the metal. Trichloroethylene is non-inflammable and shows considerable toxicity in vault fumigation at temperatures of 80°F. or over. It should prove to be exceedingly valuable for mixing with more toxic compounds to reduce the fire hazard.

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MR. E. W. BERGER: I would like to ask whether a mixture of carbon disulphide and carbon tetrachloride has been made, and with what results? It seems to me there are possibilities involved.

MR. R. C. ROARK: With the ordinary temperatures the vapor pressure of carbon disulphide is so high that when you mix it with carbon tetrachloride it tends to separate and you have a fire hazard in the mixture. To get a mixture of the two that is practically free from fire hazard you would have to use about 95 volumes of carbon tetrachloride and only 5 of the carbon disulphide. There you are reducing your carbon disulphide content so much, the toxicity of the resulting mixture would be very little better than the carbon tetrachloride alone.

VICE-PRESIDENT J. H. MONTGOMERY: The next is a paper by R. C. Smith.

HOUSE AND MILL FUMIGATION WITH CALCYANIDE

By ROGER C. SMITH, *Agricultural College, Manhattan, Kansas*

(Withdrawn for publication elsewhere)

MR. C. A. WEIGEL: Have you used any of the diluted forms of this fumigant? It is my understanding that several kinds are available, such as 15 per cent and 20 per cent of cyanogen content.

MR. R. C. SMITH: Those are intended to be used for application on the plants. Understand, these remarks I am making do not represent any exhaustive tests. It has not shown up so well in the greenhouse work, for example, but we really have made a serious attempt in that connection.

MR. C. L. METCALF: I would like to ask about the necessity of applying this material. In fumigating our fraternity house recently we found the most difficult thing in the fumigation was to get material on papers scattered over the rooms. Where we did not succeed in scattering it on papers, we had no difficulty whatever in readily removing it with the vacuum cleaner. I am wondering if we should not dispense with the recommendation of scattering it on newspapers, because it certainly does complicate the matter of application.

MR. R. C. SMITH: I stated in the paper it may be applied to papers or spread out on the floor. In mills and warehouses it is often applied in that way. The point in applying it on papers is you can roll them up and take them away.

MR. W. V. BALDUF: It was applied and exposed for two and one-half months without any ill effects whatever.

VICE-PRESIDENT J. H. MONTGOMERY: The next paper is by W. P. Flint and J. C. Frankenfeld.

PREVENTING INSECT DAMAGE TO STORED SEED GRAIN[1]

By W. P. FLINT, *Chief Entomologist, Illinois State Natural History Survey*, and
J. C. FRANKENFELD, *Junior Entomologist, U. S.
Bureau of Entomology*

ABSTRACT

A number of materials, mainly in the form of dusts, have been tested to find their value in preventing insect damage to stored seed wheat. In most of these experiments the dusts were mixed directly with the wheat which was exposed for three months in a room where there were large quantities of heavily infested grain.

A mixture of one-half fluid ounce of crude creosote to one pound of hydrated lime, mixed with the wheat at the rate of one-fourth ounce to one pound of wheat, gave practically complete protection from insect damage and did not injure the germinating qualities of the wheat. Several other materials also gave very good protection to the wheat.

It is often desirable to hold over on farms from one season to another small amounts of grain for seed. In many cases it is difficult for a farmer to fumigate or heat-treat such seed grain to prevent damage by insects. If such grain could be mixed with some inexpensive material that would protect it from insect injury, and at the same time would not lower the germinating qualities, it would be the most convenient method of handling it. The following experiments show that this can be done.

Repeated tests with a number of different substances, carried on over a period of several years, have shown that certain materials will greatly reduce insect damage to stored grain or seed. In these tests, the grain used consisted of wheat exposed to heavy infestation by the Grain and Rice Weevils, the Angoumois Grain Moth, and several other insects.

Of the various materials tried, the one giving the greatest promise from the standpoint of availability, cheapness, and the fact that it is non-poisonous, was a mixture of crude creosote and hydrated lime. This was made by mixing one-half fluid ounce of crude creosote to one pound of hydrated lime. Other materials tested include several copper compounds, sodium and calcium fluosilicates, sodium arsenite solution, lime and various clays. The materials were used chiefly as dusts and could easily be mixed with the grain. In the case of the sodium arsenite treatments, the 50% stock solution was first mixed with the carrier, which was then mixed with the grain. These mixtures were used with the idea of giving protection from both mice and insects, they reduced germination of the seed.

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[1] Contribution from Project 14.1 of the Illinois Natural History Survey.

While in most cases the entire amount of grain was mixed with the repellant or toxic material, a few treatments were tried in which only the top two inch layer of grain was treated.

Calcium fluosilicate proved more effective than sodium fluosilicate, but the sodium fluosilicate used was a rather heavy dust and settled down rapidly, so only a small amount adhered to the grain.

In carrying on these experiments, two different kinds of containers were used. In the earlier experiments, 5 gallon earthenware jars were used, for which wooden boxes were later substituted. The earthenware jars being glazed on the inside prevented the weevils from leaving the jars once they entered them, thereby making it impossible to make any observations on the possible repelling action of the treatments.

Each series of treatments was run in duplicate. The treated grain was arranged so as to give each treatment an equal chance of becoming infested from heavily infested lots of grain placed in close proximity to the treated samples. The accompanying diagram will show the general plan of arrangement of treatments used in all experiments:

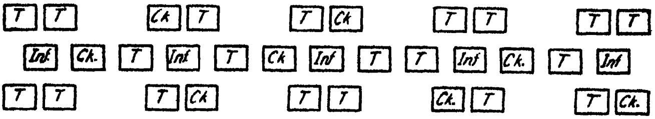


Fig. 5.—Diagram showing the arrangements of boxes used in the experiments. T = Treated grain; Ck. = Checks; Inf. = Infested grain.

Each series of treatments was left exposed to heavy infestation for three months, after which two pounds of grain was taken from each lot and carefully examined for dead and living insects.

In determining the percentage of injury, 2,000 grains were taken at random from a well mixed sample and the number of injured grains counted.

The following Table gives the results of these treatments.

TABLE 1

Treatment and Dosage	No. of Tests	Per cent Insects Dead	Per cent Grain Injured	Average Per cent Germination
Hydrated lime 1 lb., crude creosote ¼ oz.	9	100.0	0.94	89.9
Hydrated lime 4 oz. to 1 lb. grain	3	98.1	1.69	
Hydrated lime ¼ oz. to 1 lb. grain	2	74.2	1.13	94.0
Gypsum ¼ oz. to 1 lb. grain	2	77.0	1.30	92.0
Calcium fluosilicate 1 oz. to 1 lb. grain	4	90.0	0.42	93.0
Calcium fluosilicate ¼ oz. to 1 lb. grain	6	100.0	0.69	90.0
Sodium fluosilicate 1 oz. to 1 lb. grain	2	97.6	0.65	
Sodium fluosilicate ¼ oz. to 1 lb. grain	2	100.0	0.52	
Bentonite ¼ oz. to 1 lb. grain	2	7.35	39.65	
Copper stearate 1 oz. to 1 lb. grain	1		0.05	
Copper stearate ½ oz. to 1 lb. grain	3	100.0	0.70	93.0
Copper stearate 1/6 oz. to 1 lb. grain	1	82.0	0.60	99.0
Copper stearate ¼ oz. to 1 lb. grain (Top 2 in. of grain treated)	2	21.0	37.05	78.0
Copper carbonate ½ oz. to 1 lb. grain	1		1.40	93.0
Copper carbonate ⅓ oz. to 1 lb. grain	1	79.8	0.85	94.0
Tennessee Ball Clay No. 7, 4 oz. to 1 lb. grain	1		1.30	91.0
Tennessee Ball Clay No. 7, 1 oz. to 1 lb. grain	1		4.20	93.0
Tennessee Ball Clay No. 7, ½ oz. to 1 lb. grain	1		0.70	83.0
Sodium arsenite ½ pt. Bran 1 lb. to 10 lb. grain	1	100.0	0.20	69.5
Sodium arsenite ¾ pt. Bran 1 lb. to 10 lb. grain	1	100.0	0.90	
Sodium arsenite ½ pt. Corn Meal 1 lb. to 10 lb. grain	1	100.0	0.90	
Sodium arsenite ½ pt. Corn Flour 1 lb. to 10 lb. grain	1	100.0	1.25	
Sodium arsenite ¼ pt. to 10 lb. grain	2	100.0	0.27	00.0
Sodium arsenite ⅛ pt. to 10 lb. grain	2	100.0	0.75	00.0
Kentucky Ball Clay No. 9, 1 oz. to 1 lb. grain	2	5.65	51.65	75.0
Checks	15	33.33	18.43	90.8

Of the materials tested, the crude creosote-hydrated lime mixture appears to be the most feasible for use. It has a repelling as well as a toxic effect. It would be a safe material to use, as it is only mildly poisonous to most animals. Calcium fluosilicate, although giving as good protection as the hydrated lime-crude creosote mixture, would poison larger animals if taken internally in large amounts. Where copper carbonate is used quite generally in treating grain for smut, it is interesting to note that it will give a fair degree of protection against insects.

Mr. G. A. Dean: I would like to inquire of Mr. Flint whether he would have us infer this can be used with safety for milling purposes.

Mr. W. P. Flint: The tests were not run with the idea of milling purposes. They were run with the idea of protecting small amounts of seed grain. We frequently have letters coming in from men who want to carry over 50 bushels or 100 bushels of seed wheat from one year to another. They want to get some material they can put with that to give them reasonable protection. It is of real help to them.

Mr. J. L. Horsfall: I would like to ask the amount used.

Mr. W. P. Flint: The amount we finally settled on for the hydrated lime creosote mixture was 1¼ ounces to a pound of grain.

Mr. G. A. Dean: The reason I asked my question was for this purpose: I seriously object to any paper or any order going out unless it safeguards very closely the use of any fumigant upon grain which injures the milling qualities.

In the last few months I have been very actively engaged in problems of this sort. Out in Oklahoma, Texas and Kansas, we have carload after carload of grain coming to the market graded by the government inspectors, creosoted or treated with lime and various petroleum products. It is absolutely worthless for milling purposes. These farmers have been treating this, and the elevator men go right into the car and spray the material in the car. Why? Because they have been led to believe this can be used with safety. In cornering the men they will tell you it can be used with safety for germination purposes but not milling purposes. The average farmer does not know that.

Unless a paper of this sort or any treatment of this sort is safeguarded you have what we have out there today. We have two suits pending, running into thousands of dollars, from the treatment of material that had creosote, lime or some petroleum product in it.

Mr. R. C. Smith: May I ask if he has a comparison between the mixture and hydrated lime alone.

Mr. W. P. Flint: We did. We had a number of tests. Nearly all the tests were with hydrated lime alone. That gave some degree of protection but not nearly as good.

Mr. E. W. Berger: I would like to direct attention to the fact I have observed in Florida where masses or quantities of corn in the shuck were heavily covered. There was a layer of corn in the shuck, and then a layer of what must have been air-slaked lime, apparently with good results, on the control of grain weevils that are so injurious to corn in storage.

I am not aware that the corn was at all injured in any way, because I remember buying some of it to feed to my chickens. Of course, this was corn in the husk. Really I see no reason why air-slaked lime or hydrated lime, being exceedingly cheap, could not be used to carry over smaller quantities of grain. The corn I am thinking of was a mass in an ordinary room, perhaps 10 by 12 or 8 by 10 feet. The room was half filled with this corn. That seems to be a method that has been in use, I presume, for a good many years as a remedy or as a means, at least, of reducing weevil infestation in corn. I couldn't tell what value it would be to other grains. It seems to me with small quantities, lime dust could easily be eliminated through a fanning mill, when it came to using it for planting, at least.

MR. W. E. HINDS: In tests in Alabama a number of years ago, lime was used quite extensively on corn in the husk. It was in storage for more than four months. In husking out the corn, it was so dusty you could hardly stand to work there, and there was little effect on the life and activity. The results seemed to be quite different from those Dr. Berger reported.

MR. G. E. SANDERS: I would like to ask him if, when the lime was used, the seed was covered and if the bin was closed so as to confine it over a long period.

MR. W. P. FLINT: In these tests it was kept in wooden boxes so the fumes could not escape. The material was mixed on the concrete floor.

VICE-PRESIDENT J. H. MONTGOMERY: The next paper is by J. L. Horsfall.

ORGANIC MERCURY COMPOUNDS FOR THE CONTROL OF INSECTS IN STORED SEEDS

By J. L. HORSFALL, *Bayer Co. Fellowship at Boyce Thompson Institute*

ABSTRACT

Several organic mercury compounds are now being used as a control measure for certain seed-borne fungi. Frequently, when the seeds are treated just before planting, it is found that they have been damaged by various stored-product insects. The experiments show that the organic mercury dusts which were included in these experiments may be used as a protective measure against bean weevils in beans and angoumois grain moth in corn, when used at the rate of 1 part of the dust to 384 parts of the seeds by weight. Dipdust is now being used by growers on beans and Bayer Dust on corn for control of certain seed-borne fungi at the same rate and

thus it may serve a two-fold purpose. The seeds should be treated before they are placed in storage if it is desired to protect them from insects.

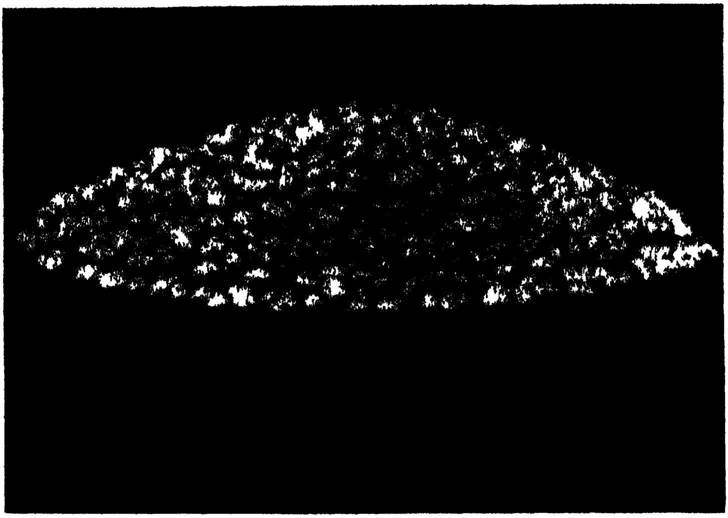
Various dry materials, other than fumigants, have been shown to have value as protective measures for dry seeds. Chambers (1) stated that maize could be protected from weevils by the use of finely powdered wood ashes. Metcalf (2) reported on the use of ground burned lime mixed with cowpeas, 1–2, by weight, for control of the cowpea weevil and his results were duplicated by Wade (3). Wade also tested sulfur and found it to be effective when used 1–14. Headlee (4) stated that beans were protected from later attack by the common bean weevil when mixed with ground burned lime, hydrated lime, calcium chloride, calcium sulfate, dolomite, Highland Clay, Bond D Clay and Milltown Ball Clay No. 9. Milltown Ball Clay No. 9, 200 mesh, used 1–10 by weight, was the most efficient and was most colloidal of all the materials which he tested. Murray (5) recommended five pounds of flowers of sulfur mixed with each bag of grain for control of weevils. Mackie (6) found that copper carbonate, 2 oz. per bu., the dosage ordinarily applied for bunt of wheat, would prevent damage by granary weevil, confused flour beetle, and angoumois grain moth.

These experiments were conducted to determine the amount of breeding of bean weevil, *Mylabris obtectus* Say, which would take place in beans and peas treated with various materials. In experiment 1, 100 adult weevils of unknown age were introduced into cages, each containing about eight ounces of uninfested beans and in experiment 2, 50 adults were used. Cages were unsealed glass jars with glass tops.

Experiments 3, 4, 5 and 6. Uninfested beans and peas in one pound and 8 ounce lots were treated and placed in open paper bags. These bags were set in a large cage covered with wire cloth in which were also placed several No. 10 bags of infested beans. Relative positions of the bags were changed at weekly intervals. At the end of one month the beans were transferred to covered unsealed glass jars and checked one and two months later. Temperature range during the experiments was 70° to 84°F.

TABLE 1. BREEDING OF BEAN WEEVIL (*Mylabris obtectus* SAY)

	Navy Beans								Alaska Peas				
Expt. & Time	1–8 Mo.		2–5 Mo.		3–2 Mo.		4–2 Mo.		5–3 Mo.		6–3 Mo.		Perct. Germ. No. 2
Treatments	No. Seeds	Perct. Infest.	No. Seeds	Perct. Infest.	No. Seeds	Perct. Infest.	No. Seeds	Perct. Infest.	No. Seeds	Perct. Infest.	No. Seeds	Perct. Infest.	
Check.....	851	48.1	605	38.5	1804	24.6	1768	34.1	844	11.4	836	29.1	70.8
Bayer Dust.	876	0	767	0	1804	0	1791	0	869	0	887	0.5	84.0
Dipdust....	878	0	743	0	1781	0.2	1644	1.03	913	0	891	2.3	92.8
Bayer 185..	959	0	834	0	1814	0.2	1812	0	877	0.2	912	0	88.8
Colloidal Clay	863	27.3	680	11.4									67.2
Talc......	999	0	733	0									65.2
Hoechst Dust	856	0	813	0									65.2
	Artificial Infestation				Natural Infestation								



Above —Untreated check
Below.—Beans treated with Dipdust before storing See Experiment 1, Table 1.

Bayer Dust, 4% nitro-phenol mercury; Dipdust, 2% nitro-phenol mercury; 6% chlor-phenol mercury. Bayer 185 differs from Dipdust in certain physical characteristics; Hoechst Dust, 26.5% copper salts. All dusts were approximately 90%, 200 mesh fineness and were applied in dry dust form to the seeds at the rate of 2.5 ounces per bushel (1–384).

A germination test was made 4.5 months after treatment, using uninfested beans from experiment 2. The percentages are averages of five replications of 50 seeds germinated in greenhouse flats. The percentage of infestation represents actual seeds infested, regardless of number of emergence holes.

The results in experiments 1 and 2 are in agreement with those in experiments 3, 4, 5 and 6. They indicate that the three organic mercury dusts, the copper dust and talc gave a very high degree of protection at the rate of 1–384. Considerable breeding took place in the check and colloidal clay. It should be borne in mind that only the beans treated with organic mercury dusts showed marked increase in germination over the check. Eggs were found in considerable numbers in the bottom of the check and colloidal clay jars, but were few to none in the other treatments. This was an indication that the adults in check and colloidal clay lived longer than those in the other treatments.

Experiments on length of life in beans receiving various treatments were conducted. Unsealed glass jars with glass covers were used as cages. Eight ounce samples of uninfested beans were given the respective treatments (1–384) and 25 adult bean weevils, age unknown, were introduced. Counts of living and dead insects were made at the end of each 24 hours for three consecutive days. A weevil was recorded as dead if no evidence of life was shown when tested with both breath and pressure. After each count both living and dead insects were returned to the jars in order to check any possible revivals. The insects were left in the respective jars for a final count at the end of

TABLE 2. PERCENTAGES OF LIVING ADULTS (*Mylabris obtectus* SAY) AT END OF TWO DAYS—25 INDIVIDUALS EACH EXPERIMENT

Treatments	1	2	3	4	5	6	7	8	9	10	Average
Check	68	68	68	80	80	68	92	84	96	72	77.8
Bayer Dust	0	0	0	0	8	0	0	0	0	0	0.8
Dipdust	16	0	4	0	8	4	0	8	4	4	4.8
Bayer 185			0	0	0	0	8	12	0	0	2.5
Colloidal Clay	68	68	68	44	48	44	48	72	76	36	57.2
Talc	8	0	0	0	12	0	8	8	4	28	6.8
Hoechst Dust	0	0	0	0	0	0	0	0	0	0	0

one week. Temperature range 70°–85°F. The results for ten replications are given in Table 2. These results check with results on breeding in Table 1.

Both Bayer Dust and Dipdust when mixed with uninfested corn, 1–384 by weight, gave perfect protection from infestation by angoumois grain moth, *Sitotroga cerealella* Oliv. Tests were run in which jars were artificially inoculated and in which open bags were exposed to adults liberated in a large cage. In some experiments the colloidal clay, 1–384, prevented breeding and in others it did not furnish protection. These organic mercury dusts are poisonous and treated seed should not be used for food purposes.

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VICE-PRESIDENT J. H. MONTGOMERY: The next paper is by S. W. Bromley.

CYANOGAS CALCIUM CYANIDE FOR THE FUMIGATION OF FLOUR MILLS

By S. W. BROMLEY, *535 Fifth Avenue, New York, N. Y.*

(Withdrawn for publication elsewhere)

President R. W. Harned resumed the Chair.

MR. S. C. CHANDLER: Will you state the percentage.

MR. S. W. BROMLEY: The per cent of cyanide in the cyanogas fumigant is 44 cyanide or 48 sodium cyanide.

ADJOURNMENT: 12 o'clock.

Thursday Afternoon Session, December 29

The Joint Session of the American Association of Economic Entomologists with the Cotton States Branch convened at 1:40 o'clock, President R. W. Harned presiding.

PRESIDENT R. W. HARNED: Professor G. M. Bentley, Chairman of the Cotton States Branch, will preside.

CHAIRMAN G. M. BENTLEY: The first paper this afternoon is by R. W. Leiby.

COTTON BOLL WEEVIL DAMAGE DURING 1927

By R. W. LEIBY, *Raleigh, N. C.*

The year 1927 was one of marked damage to cotton by the boll weevil. It was therefore thought advisable to compile the estimates of damage in the different states so that the apparent monetary value of the destroyed cotton could be recorded.

The damage resulted because of a successful winter survival of weevils that was above the average, and a fairly favorable season for development. The damage throughout the cotton states was unusually heavy in spite of a generally favorable cotton growing season.

In Texas according to Thomas the damage was 3% or 132,371 bales. In Louisiana, Hinds reports 20% or 136,250 bales. In Mississippi, Harned reports 15% or 216,176 bales. In Florida, Grossman reports 40% or 15,075 bales. In Arkansas, Isley reports 17% or 200,723 bales. Georgia thru Worsham reports 40% or 733,333 bales. South Carolina through Pepper reports 30% damage or 315,000 bales. North Carolina's reduction was 27% or 317,000 bales. The states of Alabama, Oklahoma and Tennessee which are rather heavy cotton producers are not included, but I understand that the losses were rather heavy in Alabama the largest producing state of those not listed here.

The December first forecast of the U. S. Department of Agriculture for the states listed above totals 9,854,000 bales. The reduction by the weevil in these states totals 2,086,223 bales. At 20 cents per pound the value of this reduction would be $208,622,300.

It is significant to note in passing however, that because of peculiar economic conditions, the cotton farmer will likely receive more money for his 13 million bale crop this year than he did for his 18 million bale crop of last year.

CHAIRMAN G. M. BENTLEY: The next paper is by J. M. Robinson.

FOUR YEARS OF BOLL WEEVIL CONTROL UNDER UNIFORM SOIL CONDITIONS IN ALABAMA

By J. M. Robinson, *Auburn, Ala.*

(Withdrawn for publication elsewhere)

Chairman G. M. Bentley: The next paper is by Dwight Isely.

OVIPOSITION OF THE BOLL WEEVIL IN RELATION TO FOOD[1]

By Dwight Isely, *University of Arkansas.*

Abstract

While larvae of the boll weevil, *Anthonomus grandis* Boh., feed and develop either in squares or in bolls of cotton, the adult weevils prefer squares for food. Not only are the longevity and the period of oviposition of weevils fed upon squares greater than that of weevils fed exclusively upon bolls, but squares or very small bolls are essential for reproduction. In the latter part of the season if the formation of squares stops, oviposition soon ceases. This requirement of squares for reproduction limits the number of weevils which may go into hibernation in any locality and is a factor in the local distribution of the overwintered weevils the next year.

The larvae of the cotton boll weevil[2] feed and mature either in the squares or in the bolls of their host plant. The adult weevils, however, prefer squares for food. When fed exclusively upon squares, according to Hunter and Hinds,[3] the longevity of weevils greatly exceeded that of those fed exclusively either upon bolls or foliage. These investigators also state that early in the season squares are apparently essential for reproduction, since weevils fed exclusively upon foliage not only deposited no eggs but dissection showed their ovaries to be undeveloped, while oviposition became normal when squares were supplied. The formation of the first squares thus marks the beginning of the reproductive period of that season, and makes it the starting point of seasonal history.

Weevils fed exclusively upon large bolls, in cage experiments carried on by the writer in the fall of 1926, failed to deposit eggs. To determine definitely if bolls, like foliage, do not contain necessary food for the development of eggs, a series of cage experiments were carried out in 1927, comparing not only squares and large bolls, but small bolls as well. The fact that bolls as food for weevils might be unfavorable to oviposition has been suggested previously. To their discussion of effect of feeding upon bolls on longevity, Hunter and Hinds add this sentence: "There are indications that the production of eggs does not continue normally when bolls alone are accessible for food."

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[1] Research Paper No. 69, Journal Series, University of Arkansas.

[2] *Anthonomus grandis* Boh., Order Coleoptera, family Curculionidae.

[3] Hunter, W. D., and Hinds, W. E. The Mexican cotton boll weevil. U. S. D. A. Bur. Ent. Bul. 51, 1905, pp. 45–46.

The experiments to be described are based upon daily oviposition records of 110 mated pairs whose food was controlled from the date of emergence until death. In addition, the records of mated pairs were supported by daily records of oviposition from larger cages, each containing 10 pairs of weevils. Oviposition in these large lot cages was not recorded for the entire lives of the weevils, however. All weevils used were reared from squares.

Eggs recorded from all lots were actually dissected out of the square or boll, and not based on punctures. All the food was changed daily and all squares and bolls were examined before placing them in the breeding cages to be sure they were free of punctures. Most of the weevils used emerged between July 13 and July 23, although records were taken from a supplementary series which emerged between August 15 and 24.

The weevils in the paired series were divided into five groups which were classified according to the food received from the date of emergence as follows: (1) squares; (2) small bolls; (3) large bolls; (4) squares for 10 days after emergence, then changed to large bolls; (5) large bolls for 10 days after emergence and then changed to squares. Under the classification "small bolls," was included bolls ranging in size from those from which blossoms had just fallen up to those three-quarters of an inch in diameter. The term "large bolls" was used to designate bolls about three to four weeks old. In the caged lots only squares and large bolls were fed.

Weevils fed squares exclusively deposited an average of 110.30 eggs to each female, the largest number of eggs for a single female being 283. The minimum was two eggs, and five weevils deposited less than 10 eggs. The oviposition period averaged 21.18 days with a maximum of 51 days. The average number of eggs deposited a day was 4.83 for each female. The average longevity was 36.27 days. In six large lot cages where weevils were fed exclusively on squares over a period of 20 days, there was an average of 2.13 eggs deposited daily for each pair.

Weevils fed exclusively on small bolls deposited eggs with fair regularity. The average number of eggs deposited by each female was 17.70, and the maximum 49. The oviposition period averaged 13.80 days, and the average daily oviposition was 1.24 eggs for each female.

The average longevity was 25.50. All of these averages are less than the corresponding ones for weevils fed squares, although the only striking difference is in oviposition.

Most of the weevils fed exclusively upon large bolls deposited no eggs. From the paired series, records were secured from only two females, each of which deposited a single egg. From the large cage lots a total of only four eggs were secured from six cages containing 120 weevils. The longevity was 23.17 days, markedly less than that of weevils fed squares.

None of the weevils which were fed upon large bolls for the first ten days after emergence and then changed to squares, began oviposition until after the change was made. Within a few days following the change to squares as food, 80 per cent of the weevils began depositing eggs; the average interval between the time of change of food and the beginning of oviposition was 3 72 days. After beginning to deposit eggs the rate of oviposition never quite equaled that of weevils fed upon squares from the time of their emergence, and the total oviposition period was shorter The average number of eggs deposited was 34.90, the average oviposition period 10.30, and the average daily oviposition for this period was 3.39.

Weevils fed squares for 10 days and then changed to large bolls began ovipositing, as might be expected, before the change was made. After the change of food, oviposition stopped in from 1 to 7 days, with an average of 3 days The average number of eggs deposited by each female was 11.60, but of this total the average after the change of food was only 3.30.

The longevity and the oviposition periods of weevils fed exclusively upon squares were greater than those of weevils fed upon bolls. These results are neither as striking nor as important, however, as are the results on oviposition, as indicated both by the average daily records, and the average total oviposition. These records are summarized in Table 1.

TABLE 1. OVIPOSITION OF THE COTTON BOLL WEEVIL IN RELATION TO SQUARES AND BOLLS AS FOOD.

Food	Number of Pairs	Average Oviposition Period	Average Number of Eggs a Day Per Female	Total Number of Eggs Deposited per Female		
				Maximum	Minimum	Aver.
Squares	50	22.82	4.83	283	2	110.30
Small bolls	20	14.30	1.24	49	1	17.70
Large bolls	20	—[1]	—[1]	1	0	0.10

[1] Only two females deposited eggs.

According to these data, in the latter part of the season, as in the beginning, the reproduction of weevils is dependent upon squares, or at least upon small bolls, being available for food. Small bolls disappear from a cotton field soon after setting of squares stops, and when weevils have only large bolls for food oviposition soon ceases.

Since cotton is indeterminate in its fruiting habit, squares are often formed in the rich bottom lands until frost, and under such conditions weevils reproduce until the end of the season. On the light upland soils of Arkansas, however, fruiting usually stops early in the fall, sometimes two months before frost. Field observations indicate that weevils have a tendency to migrate from these fields to those where squares are abundant, and there larvae may be found commonly in both bolls and squares until the end of the season.

There appears to be a definite relationship between the abundance of squares in a field late in the season and the presence of overwintered weevils in that field the following spring. It is probable that the availability of food in the fall essential for reproduction is as important a factor in the boll weevil's success in maintaining itself in a given locality from one season to the next as suitable shelter for hibernation.

MR. CLAY LYLE: I would like to call attention to one thing in Mr. Isely's paper, or rather his lantern slide. Mr. Isely's lantern slide was printed in such a manner that we could read it halfway back here. This is something that has not been true of a great majority of the lantern slides used in our discussion. I am wondering if this is not something for the group to think about, a better method of projecting lantern slides, or some other method entirely, such as charts.

MR. F. G. HOLDAWAY: I would like to ask if Mr. Isely can tell us just what it was that was in the squares and was not present in the bolls, whether it is purely a matter of moisture or a matter of difference in chemical content.

MR. DWIGHT ISELY: I cannot answer that question definitely. I suppose nitrogen content is a factor, for the weevil is largely a feeder on pollen in squares. I don't know how that could be answered in the case of the small bolls, but they probably contain more nitrogen than large ones.

CHAIRMAN G. M. BENTLEY: The next paper is by H. W. Walker.

THE PREPARATION OF A SPECIAL LIGHT SODIUM FLUOSILICATE AND ITS USE AS A BOLL WEEVIL POISON[1]

By H. W. Walker

Abstract

Two serious objections to the use of commercial sodium fluosilicate as a boll weevil poison are its lack of covering power, due to its comparatively high apparent specific gravity, and its plant toxicity. These have been overcome by incorporating from 10 to 20% colloidal silica with the sodium fluosilicate during the commercial process of manufacture.

The resulting special light sodium fluosilicate, containing at least 80% Na_2SiF_6 causes no economic plant injury and is a quicker weevil killer than commercial calcium arsenate. Under certain field conditions, however, it does not adhere to the plant so well as calcium arsenate. This lack of adherence under extremely moist conditions can probably be overcome by the incorporation of a small amount of adhesive during the process of manufacture.

Barium fluosilicate similarly prepared is about as effective as the sodium salt.

Introduction. Of the very large number of substances tested by the Chemical Warfare Service as boll weevil poisons, sodium fluosilicate was among the most effective.[2] In tumbler and cage tests during 1924, 1925, and 1926, the commercial sodium fluosilicate caused a higher and quicker mortality among the weevils than commercial calcium arsenate, but it has two distinct disadvantages. In the first place its apparent density is such that it requires from 3 to 5 pounds of ordinary sodium fluosilicate to cover the same area that one pound of calcium arsenate will cover effectively; and in the second place, it is rather dangerous to foliage when not diluted with lime. Even the so-called "Light" and "Extra Light" fluosilicates on the market are not so light as calcium arsenate, and in the case of the "Extra Light" the Na_2SiF_6 content is reduced so much as to lose considerable of its killing effect. Our experiments showed that the Na_2SiF_6 content could not be reduced much below 80% without the material losing some of its efficiency. Sodium fluosilicate containing only 60% Na_2SiF_6 was found to be less effective against the weevil than commercial calcium arsenate. (Most of these "light" and "extra light" fluosilicates are dry mixtures of sodium fluosilicate and alumina or Kieselguhr).

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[1] Published by permission of Chief, Chemical Warfare Service.

The following men were actively engaged in carrying out the experimental work in the field: H. W. Walker, H. S. McQuaid, G. A. Sachs, B. Gehauf, J. G. Hartnett, D. Ehrenfeld, L. A. Forrest, W. A. Shands, R. G. Pridmore, J. F. Touchstone, V. I. Greer, and Lloyd Brunk. In addition, F. M. Pralatowski, R. D. Kulp, and T. F. McCabe were employed at Edgewood Arsenal, besides which the personnel of the Analytical, Engineering, Organic, and Physical Departments of the Chemical Division, Chemical Warfare Service, assisted at various times.

[2] Progress Report, Chemical Warfare Service Boll Weevil Investigation, Ind. & Eng. Chem., Vol. 19 No. 6, June, 1927.

PREPARATION OF SPECIAL Na_2SiF_6 IN THE LABORATORY. Experimental work was undertaken to reduce the apparent density of sodium fluosilicate and at the same time decrease plant injury. It was found that this could be effectively accomplished by incorporating about 20% colloidal silica with the fluosilicate during its preparation. About 100 pounds of this material was made in small batches in the laboratory for the 1926 work, and also about 50 pounds of barium fluosilicate was made by passing silicon tetrafluoride gas into $Ba(OH)_2$ solution.

LARGE SCALE MANUFACTURE. In order to obtain sufficient amounts of both sodium and barium fluosilicates for the 1927 field work, arrangements were made with the American Agricultural Chemical Company at their Lazeretto Works, Baltimore, Md., to make this material according to the Chemical Warfare Service specifications and method. About 1100 pounds of each of these materials was manufactured without any serious deviation from the regular large scale plant practice. Later, 375 pounds more of sodium fluosilicate was made at this same plant. This special light sodium fluosilicate can be obtained as a by-product in the manufacture of acid phosphate without change of apparatus and without additional apparatus.

It is estimated that every ton of phosphate rock potentially contains 100 to 125 pounds of sodium fluosilicate (97%). Actually the recovery is 20 to 30 pounds Na_2SiF_6. This apparent discrepancy occurs because a considerable portion of the silicon tetrafluoride reacts with the water present and never actually escapes as a gas, remaining in the resulting acid phosphate as a fluosilicate. There were 3,481,819 long tons of phosphate rock sold or used by producers in the United States in 1925,[3] which indicates a source of supply for all the sodium fluosilicate that could be used for insecticides for a long time to come.

CAGE TESTS—GAINESVILLE, FLA., 1926. The following slides summarize the results obtained from cage tests using special light sodium fluosilicate in comparison with calcium arsenate:

DISCUSSION OF CAGE TESTS. These tests were conducted on field cotton between August 20 and October 2, 1926, at Gainesville, Florida. The plants used in the large cages averaged at least 3 feet high and were much larger than would ordinarily occur in the field at the time when most of the poisoning would take place.

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[3] "Mineral Resources of the United States, 1925, Part II, p. 148."

The cotton used in the small cages was either late cotton or second growth cotton obtained by trimming off the large plants and fertilizing heavily to induce new growth. These plants averaged about 18 inches in height and are a much fairer comparison of the relative effectiveness of the materials. It was noted that most of the weevils in the small cages remained on the plant, while a considerable number of those in the large cages stayed on the side of the cage. This probably accounts for the higher kill in the small cages.

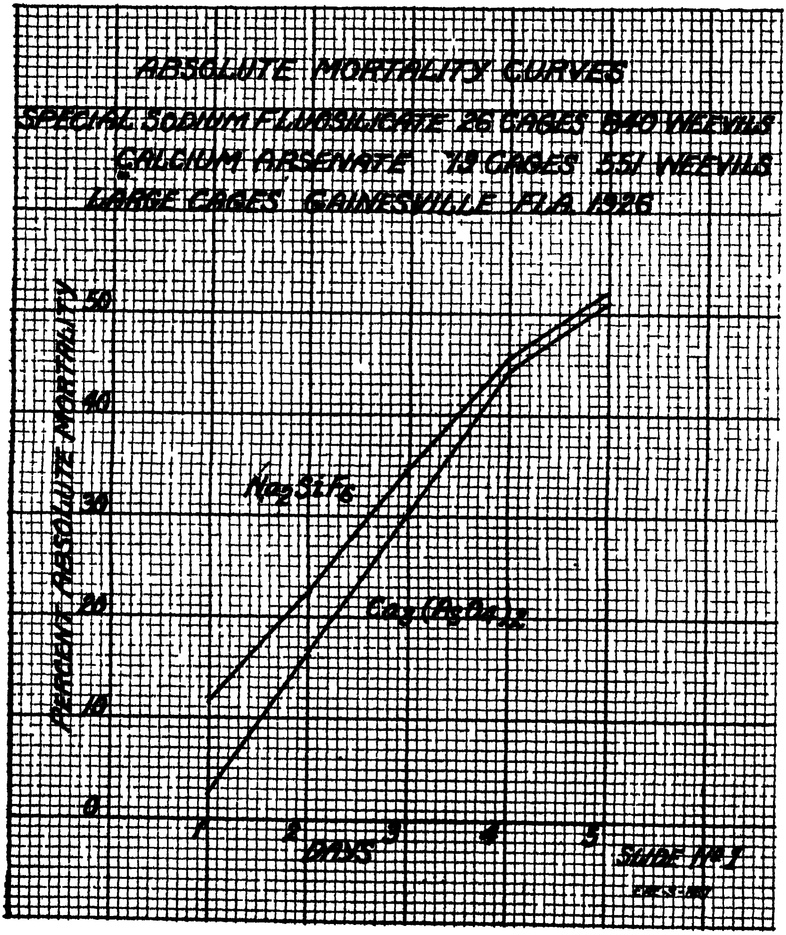

Fig. 6

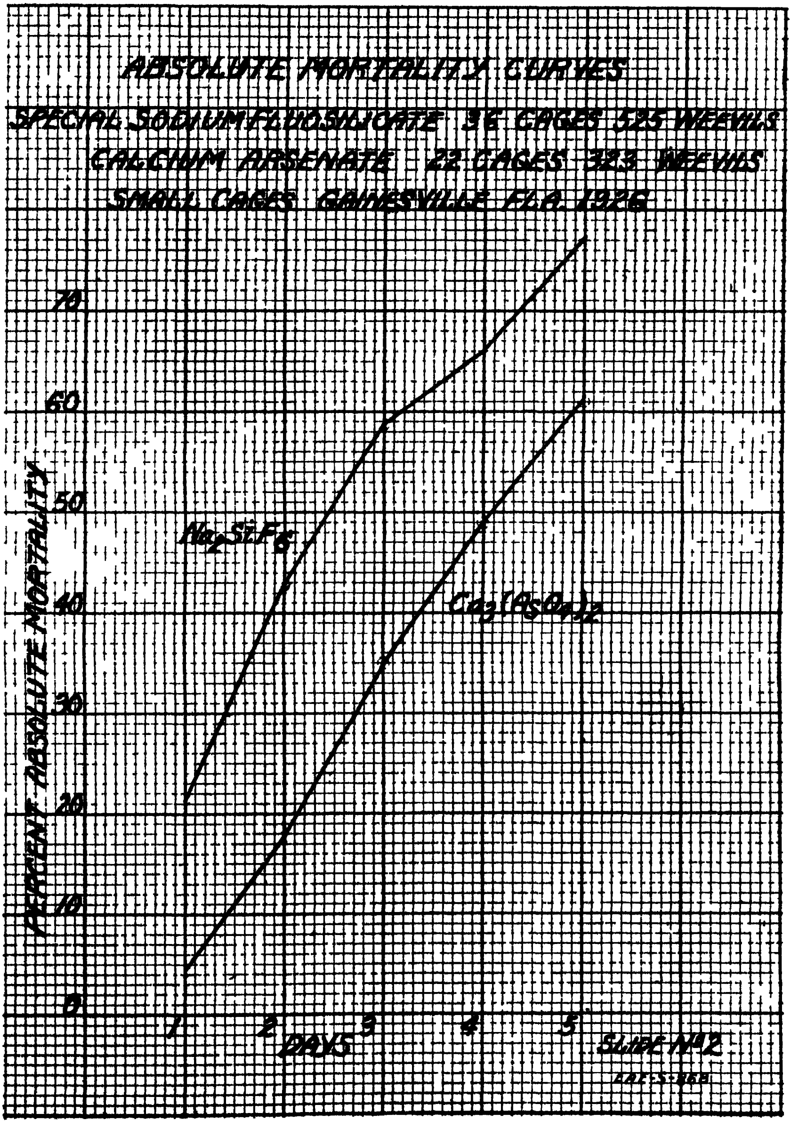

Fig. 7.

A slightly higher average weight of sodium fluosilicate than of calcium arsenate was used in the large cages, while the reverse was true in the small cages. In its present form the sodium fluosilicate does not stick to the plant so well as calcium arsenate, and in the effort to obtain about the same amounts of each poison on the foliage, the discrepancy was more marked when the leaf area was considerably greater. The question of the relative sticking qualities of the sodium fluosilicate and calcium arsenate will be discussed more fully later. (While both the large and small cages were equipped with oilcloth covers so that the almost daily rainfall would not spoil the tests, the sides were not protected and the elements had more chance to blow off and wash off the poisons in these cages than in the small ones.)

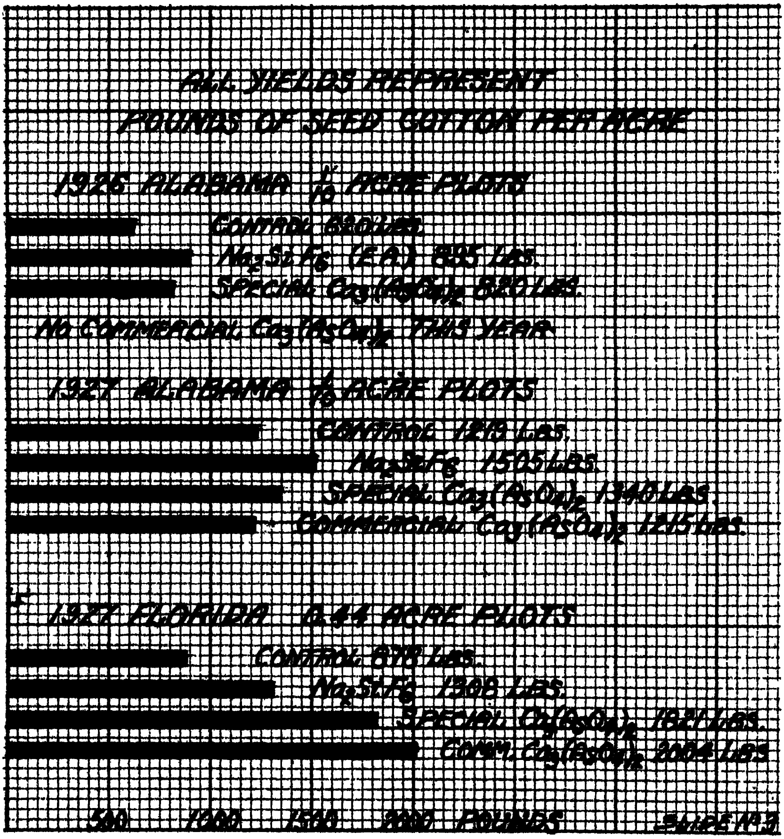

Fig. 8.

In spite of the removal of more of the sodium fluosilicate than of the calcium arsenate from the plants by wind and rain, in both cases the fluosilicate shows a higher mortality and a quicker killing effect than does the calcium arsenate.

FIELD PLOT TESTS. The yields from the field test plots with sodium fluosilicate are shown on Slide No. 3.

No plots were run in 1926 at Alabama using commercial calcium arsenate.

The Alabama tests were run by Mr. Robinson of the Alabama Experiment Station. The sodium fluosilicates were furnished by the Chemical Warfare Service. In both of the above cases the infestation was late and light and poisoning was not started until the infestation reached 10%. Two applications were made in 1926 and three in 1927, and slightly less of the sodium fluosilicate than of the calcium arsenate was used for each application. There was no burning of the foliage by either the sodium fluosilicate or the calcium arsenate.

DISCUSSION OF FIELD TESTS. The Alabama tests show an increased yield for both years for the fluosilicate plots over the unpoisoned plots. This increase is definite although the infestation was light both years. The 1927 tests show a difference of 290 pounds of seed cotton per acre between the sodium fluosilicate plot and the calcium arsenate plot in favor of the former. Conditions in Alabama were favorable for the sodium fluosilicate.

While both the sodium fluosilicate and the calcium arsenate show increased yields over the unpoisoned plots at Gainesville, Fla., the commercial calcium arsenate gives decidedly better yields than the fluosilicate. This is undoubtedly due to the fact that, because of the heavy dews and frequent rains, the sodium fluosilicate was washed off the plants to a much greater degree than the calcium arsenate. Field observations to this effect were confirmed by laboratory tests of the relative sticking qualities of these materials, which showed that the calcium arsenate adheres to the plant under extremely damp conditions much better than the fluosilicates. There would seem to be no question but that the fluosilicates can be made to adhere equally as well as calcium arsenate, and it is known that if they are available on the plant for the weevil they are at least as toxic as calcium arsenate.

The addition of a small amount of adhesive, such as starch, glue, casein, syrup, etc., to the solution of sodium carbonate before adding the fluosilicic acid would undoubtedly give increased sticking in some proportion to the quantity of adhesive used.

Barium fluosilicate was also tested in cage and field tests but showed only about the same toxicity as the sodium compound and is, therefore, not competitive on account of the increased price of barium salts. In preliminary tests calcium fluosilicate was not equal to sodium fluosilicate in killing power and caused more plant injury.

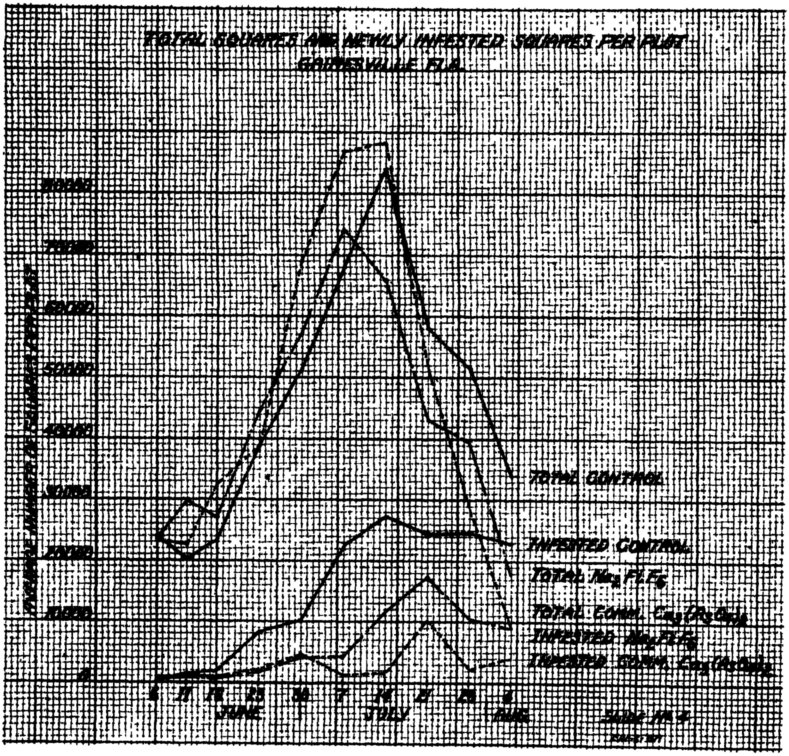

Fig. 9.

Slide No. 4 presents the infestation data from the Gainesville field tests, showing the average total squares per plot and the average newly infested squares per plot.

In addition to these tests, field tests were run at Tifton, Georgia, and Summerville, South Carolina, but the cotton at Summerville was ruined by water and insufficient drainage, and shed all its bottom crop, while the excessive rains at Tifton also caused shedding after the crop seemed made. No definite conclusions can be drawn from the data obtained from these tests.

Also, sufficient quantities of sodium fluosilicate and other poisons for field tests were shipped to W. E. Hinds, Baton Rouge, La., and B. R. Coad, Tallulah, La. The data from these tests have not been received at this writing.

SYRUP MIXTURES. Cage tests run in 1927 indicate syrup mixtures of sodium fluosilicate to be at least equally as effective as the same strength mixtures of calcium arsenate. They do not injure the plant and the sodium fluosilicate also seems to prevent the syrup from fermenting and turning sour, and it appears to be equally as effective after several days' standing as when freshly prepared. No field tests were run with syrup mixtures, and it is felt that additional cage and field tests should be conducted along these lines.

GENERAL USE OF FLUOSILICATES AS INSECTICIDES. Commercial fluosilicates are used largely in the ceramic industry and also in the building industry for hardening stone surfaces. They have been used as disinfectants and antiseptics and have been suggested as food preservatives. Marcovitch[4] in 1924 found them to be effective against the Mexican bean beetle. He also made some preliminary tests against the boll weevil. Baeg[5] advocates their use as a control for blister beetles. Osborn[6] found commercial sodium fluosilicate to be more effective and quicker killing against the boll weevil than calcium arsenate under the condition of test. Hinds[7] has shown its possibilities as a poison against the sugar cane borer. Sodium fluosilicate is the basis of several moth remedies now on the market.

The higher apparent density and the burning effect of commercial fluosilicates have been drawbacks against the widespread use of them as field insecticides. The recent controversy on the effect of arsenic on apples and other fruit offers another possible field for fluosilicates. Experiments by the Medical Research Division of the Chemical Warfare Service at Edgewood Arsenal indicate that the fluosilicates are only one-quarter (or less) as toxic to mammals as calcium arsenate. The fact that a light fluosilicate may be easily prepared as a by-product of a large stable industry offers new possibilities for its use.

CONCLUSIONS. 1. A special "light" sodium fluosilicate having about the same apparent density as commercial calcium arsenate, containing not less than 80% Na_2SiF_6, may be obtained as a by-product of the manufacture of acid phosphate. The aim should be to keep the Na_2SiF_6 content as close to 86% as possible.

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[4] Bull. Tennessee Agricultural Station, No. 131–1924.

[5] Bull. Arkansas Agricultural Experiment Station, No. 201–1925.

[6] JOURNAL ECONOMIC ENTOMOLOGY, Vol. 19, p. 643–644.

[7] Insecticidal Control for Sugar Cane Borer, Louisiana Bull. No. 201–1927.

2. While this material is at least as toxic as calcium arsenate to the boll weevil on a pound per pound basis, under conditions where it does not remain on the cotton plant so well as calcium arsenate it is somewhat less effective in the field. This condition can probably be remedied by the addition of sufficient adhesive to produce the desired sticking qualities.

3. This special sodium fluosilicate has possible use as an insecticide in its present form in cases when increased adherence is not necessary or desirable.

4. This material when properly prepared causes no economic damage to the cotton plant.

ACKNOWLEDGMENT. The Chemical Warfare Service desires to express its appreciation of the assistance and cooperation of the U. S. Department of Agriculture and the various state experiment stations, and especially of the facilities furnished by the respective experiment stations of Georgia, Florida, and South Carolina for this work. In addition to these facilities, we received the heartiest personal cooperation from these sources. H. P. Stuckey, director of the Georgia Experiment Station; Wilmon Newell, director of the State Plant Board of Florida; and H. W. Barre, director of the South Carolina Experiment Station, on all occasions cooperated with the Chemical Warfare Service to the fullest extent. Also, W. E. Hinds, of the Louisiana State Experiment Station, and J. M. Robinson, of the Alabama Experiment Station, conducted field tests with Chemical Warfare Service materials. Our special thanks are due to R. P. Bledsoe, Georgia Experiment Station, E. F. Grossman, Florida Experiment Station, E. D. Kyzer, Clemson Coast Experiment Station, and W. C. Davis, of the Coastal Plains Experiment Station, Tifton, Ga., for their personal efforts.

CHAIRMAN G. M. BENTLEY: The next paper is by the same gentleman.

THE PREPARATION OF SPECIAL CALCIUM ARSENATES CONTAINING LESS THAN 40% ARSENIC AS AS_2O_5 AND THEIR USE AS BOLL WEEVIL POISONS[1]

By H. W. Walker

Abstract

A special calcium arsenate containing only about 20% arsenic calculated as As_2O_5 was found to be equally as effective a boll weevil control as commercial calcium arsenate in extended cage and field tests. The material caused no plant injury.

This special calcium arsenate was prepared by heating precipitated chalk and white arsenic (As_2O_3) in the presence of excess air at a temperature of 650°C. for about one hour. In this manner it was possible to prepare a calcium arsenate containing any desired percentage of arsenic as As_2O_5 up to 57.6%, the theoretical for normal calcium arsenate, $Ca_3(AsO_4)_2$. The conversion from the trivalent to the pentavalent state is practically complete, and there is scarcely any free lime formed under these conditions. Any arsenic lost in this process is recoverable on a commercial scale.

The particles of the special calcium arsenate containing only 20% arsenic as As_2O_5 consisted of an inert core of calcium carbonate covered with a coating of substantially 100% normal calcium arsenate.

This direct oxidation method of preparation is adaptable for arsenates other than calcium.

Introduction. Early in this investigation it was suspected that not all of the arsenic in calcium arsenate ingested by the boll weevil was available to the weevil as a posion.[2] Analyses of weevils killed with calcium arsenate showed they contained a much higher arsenic content than those killed by drinking arsenic pentoxide solutions.

The average arsenic found in weevils poisoned with calcium arsenate was 0.00204 mg., calculated as As, while that found in weevils killed by drinking arsenic pentoxide solutions was 0.00013 mg.

Many different mixtures and combinations of lime, limestone, or precipitated chalk with arsenic trioxide or arsenic pentoxide were investigated to determine their respective toxicities against the boll weevil and also the cotton plant. Varying percentages of the arsenious and arsenic oxides were used and different methods of effecting combination were tried, and from the data obtained in these tests it was indicated that considerably less arsenic than is contained in commercial calcium arsenate (which contains at least 40% arsenic as As_2O_5) was equally as effective and did not injure the plant. It was also suspected that, under the proper conditions, arsenic trioxide and lime or precipitated chalk could be combined in almost any desired proportions, and at the same time the arsenic could be converted to the pentavalent form without the use of any oxidizing agent other than air or oxygen. While an excess of lime tends to form basic calcium arsenates which are less soluble in the weevil's digestive tract and, therefore, less toxic than normal calcium arsenate, this difficulty may be overcome by using limestone or precipitated chalk, leaving the excess calcium in the more inert form of calcium carbonate. It was the attempt of these experiments to prepare a calcium arsenate dust each particle of which would contain an excess of calcium carbonate, most of this excess constituting the cores of the particles while their outer surfaces approached the formula $Ca_3(AsO_4)_2$.

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[1] Published by permission of Chief, Chemical Warfare Service. The following men were actively engaged in carrying out the experimental work in the field: H. W. Walker, H. S. McQuaid, G. A. Sachs, B. Gehauf, J. G. Hartnett, D. Ehrenfeld, L. A. Forrest, W. A. Shands, R. G. Pridmore, J. F. Touchstone, V. I. Greer, and Lloyd Brunk. In addition, F. M. Pralatowski, R. D. Kulp, and T. F. McCabe were employed at Edgewood Arsenal, besides which the personnel of the Analytical, Engineering, Organic, and Physical Departments of the Chemical Division, Chemical Warfare Service, assisted at various times.

[2] Progress Report, Chemical Warfare Service Boll Weevil Investigation, Ind. & Eng. Chem., Vol. 19, No. 6, June, 1927.

After considerable experimental work, it was found that mixtures of precipitated chalk and white arsenic in any desired percentage could be combined to form calcium arsenate by heating in the presence of excess air. 650°C. was found to be the best temperature, although it could be varied plus or minus 30° without serious damage. Almost complete conversion of the arsenic to the pentavalent state is obtained, and the loss of arsenic is about 20% of the original arsenic used. This loss could be recovered on a commercial scale. Practically no lime is formed at this temperature in the time required for conversion to the penttavalent state—15 minutes to 1 hour. Longer heating at lower temperatures caused excessive loss of arsenic, and heating at higher temperatures caused excessive formation of lime.

SEMI-PLANT SCALE MANUFACTURE. About 500 pounds of special calcium arsenate containing about 20% arsenic as As_2O_5 were made in 1926, and some 1200 pounds were made in 1927. Also, in 1926 about 300 pounds of material containing about 10% arsenic as As_2O_5 were prepared.

The conversion of the trivalent arsenic to the pentavalent was effected in a forge furnace using an oxidizing flame from a gas burner. Excess air was provided by natural draught.

While the method used was very crude, the product was remarkably uniform, which indicates that on a large scale it would be comparatively easy to effect the conversion of the arsenic from the trivalent to the pentavalent state. It is believed that a combination rotary reverberatory kiln, slightly tilted, could be used, or possibly a tower system in which the precipitated chalk would be fed in from the top against an upward current of hot As_2O_3 vapor and air. Any uncombined arsenic is readily recoverable on a commercial scale.

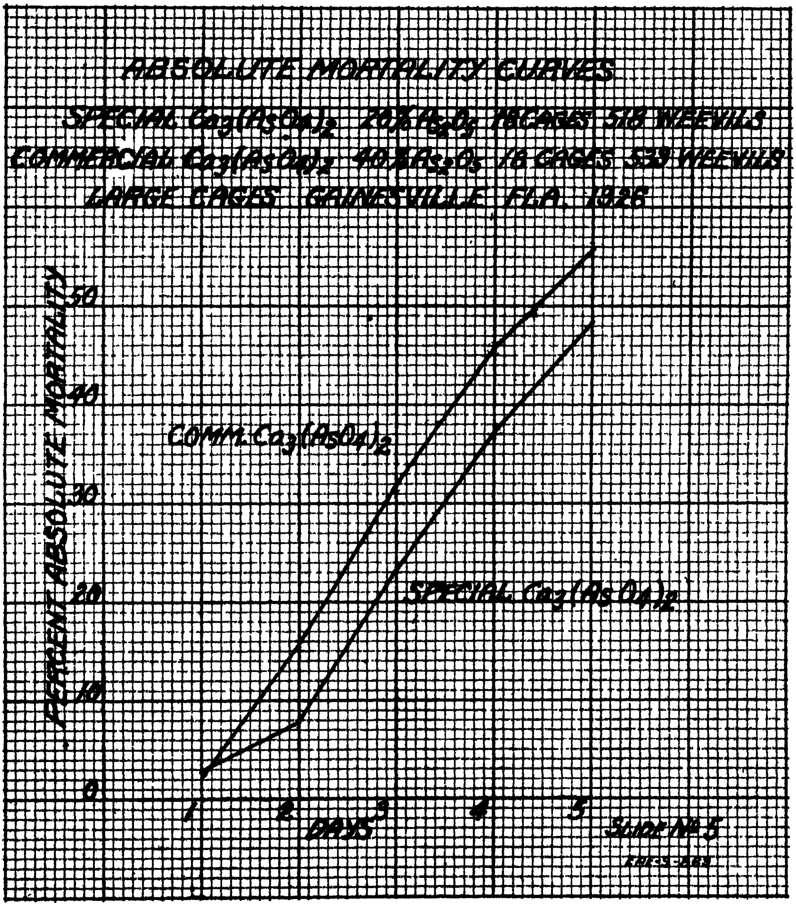

Fig. 10.

The apparent density and the fineness of the finished product are dependent on the apparent density and fineness of the precipitated chalk used. Precipitated chalk is a by-product of many industries, and can be obtained in quantity for from six to ten dollars per ton.

The average analysis of the approximately 20% As_2O_5 content calcium arsenate used in 1927 was 22.3% arsenic as As_2O_5, less than 0.2% trivalent arsenic as As_2O_3, less than 0.50% lime as CaO, and about 0.50% water-soluble arsenic as As_2O_5. The apparent density compared to calcium arsenate was 1.01.

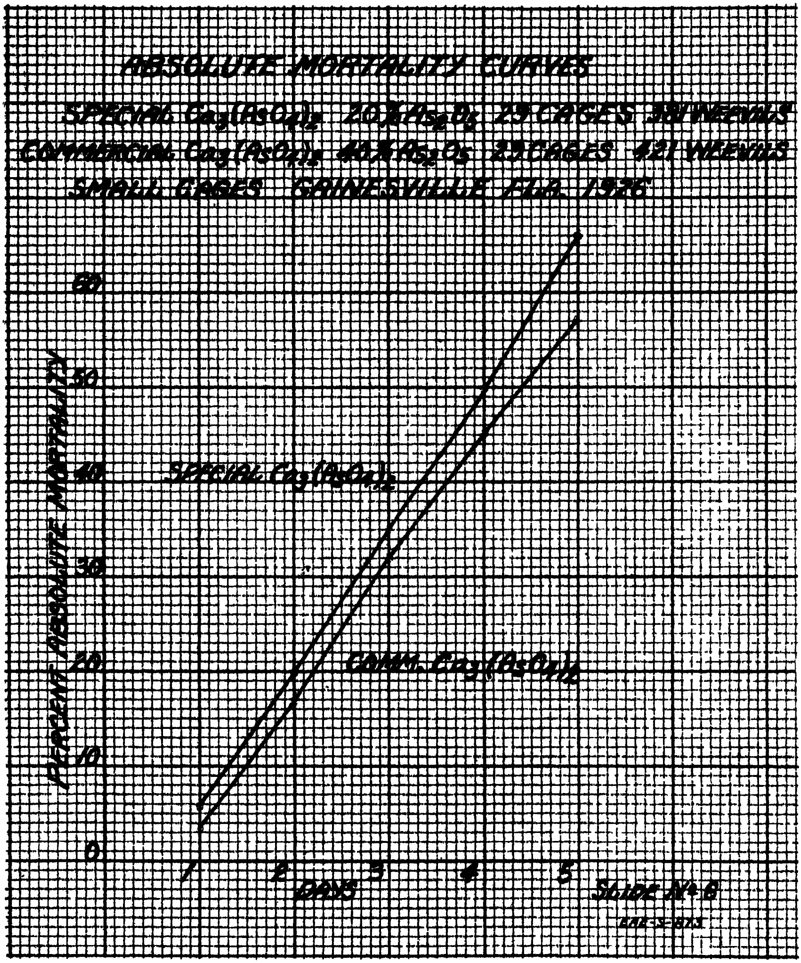

Fig. 11.

The 1926 material had approximately the same analysis except that the apparent density compared with that of calcium arsenate was 1.25 due to the use of a denser grade of precipitated chalk.

CAGE TESTS—GAINESVILLE, FLA.,—1926. Slides Nos. 5 and 6 summarize the results obtained from cage tests using special calcium arsenate (20% As_2O_5) in comparison with commercial calcium arsenate.

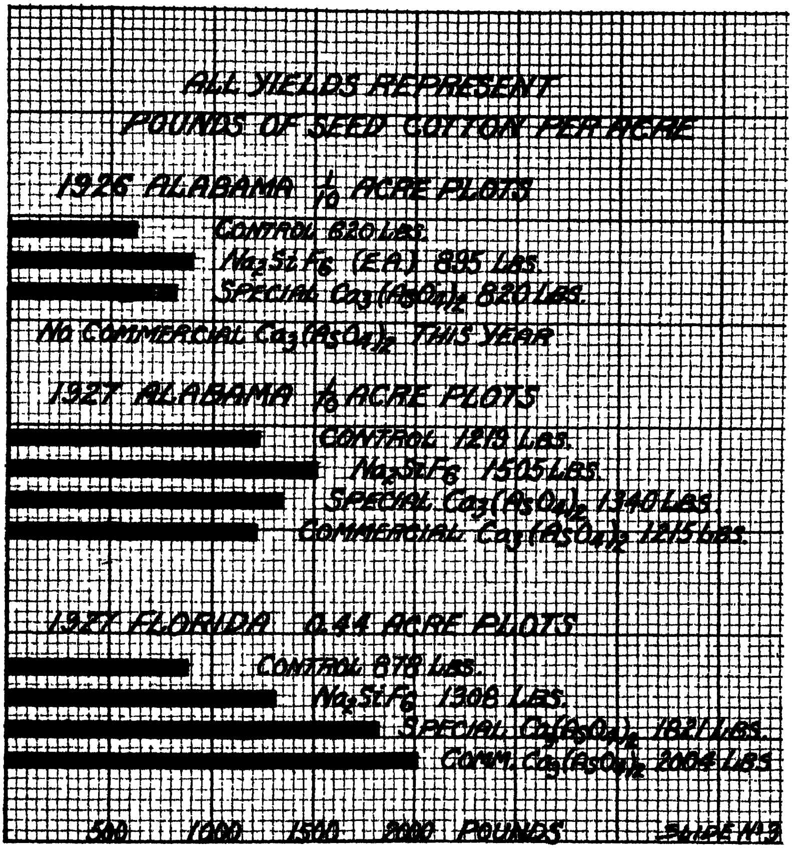

Fig. 12.

DISCUSSION OF CAGE TESTS. The comments regarding cage tests already given in the previous paper[3] apply to these tests.

The average weights of the poisons used per cage are in about the same ratio as the apparent densities of the two materials, 1.25 parts for the special calcium arsenate to 1 part of the commercial.

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[3] "The Preparation of a Special Light Sodium Fluosilicate and its use as a Boll Weevil Poison."

It will be noted that the special calcium arsenate (20% As_2O_5) appears at least as toxic as the commercial calcium arsenate (40% As_2O_5).

There was practically no plant injury caused by either of these materials.

A special calcium arsenate containing only about 10% arsenic as As_2O_5, while definitely toxic to the weevil, was appreciably less effective than commercial calcium arsenate. It is believed that this percentage is too low to form a contiguous coating on the particles, or if such a coating is formed it is not sufficiently thick to give the best results. It is indicated that the minimum effective arsenic content for calcium arsenate is between 10 and 20% calculated as As_2O_5.

FIELD PLOT TESTS. The yields from the field test plots with special calcium arsenate are shown on Slide No. 3.

These tests were also run by Mr. Robinson, of the Alabama Experiment Station, with special calcium arsenate furnished by the Chemical Warfare Service. There was no burning of the foliage in any case.

DISCUSSION OF FIELD TESTS. The Alabama tests show an increased yield for both years for the special calcium arsenate plots over the unpoisoned plots, although not so great an increase as the fluosilicate plots showed. The 1927 tests show a difference of 125 pounds of seed cotton per acre between the special calcium arsenate (20% As_2O_5) and commercial calcium arsenate in favor of the special, but the Florida plots show an increase of 183 pounds per acre in favor of the commercial calcium arsenate. It is believed that these differences are so comparatively slight that the two materials may be regarded as equal. The gain of both calcium arsenates over the unpoisoned in Florida is very definite, averaging over 1,000 pounds per acre. Slightly less of the special calcium arsenate than of the commercial was used, and there was no appreciable plant injury in either case. If properly prepared, there should be no real difference in the dusting properties of special and commercial calcium arsenates. On Slide No. 7 are shown the infestation data from the field tests at Gainesville, Florida.

PREPARATION OF OTHER ARSENATES BY DUST OXIDATION. Preliminary tests have indicated the possibilities of this method of preparation for other arsenates, notably the arsenates of copper, iron, zinc, and magnesium. No attempt was made to determine the best temperature of ignition for each respective compound, but in spite of this the evidence of their formation is definite. In some cases it is possible to use sulphates in place of carbonates.

Also, it was found possible to prepare a lead arsenate by heating white lead ($PbCO_3$) and white arsenic in a similar manner.

By using an excess of white arsenic it was found possible to make a calcium arsenate containing practically the theoretical arsenic content of normal calcium arsenate, ($Ca_3(AsO_4)_2$)—57.6% As_2O_5.

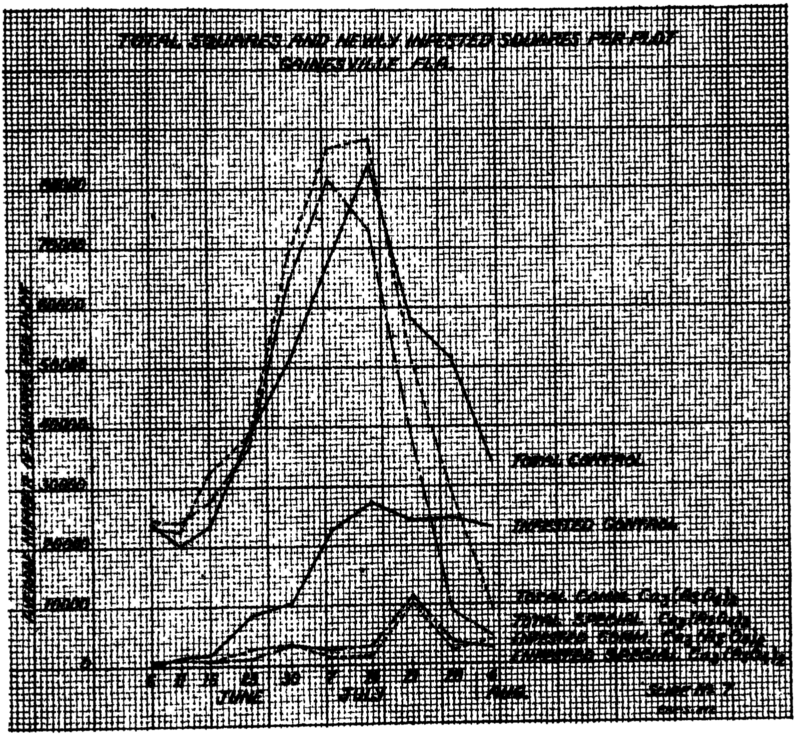

Fig. 13.

In all the above cases the materials were heated dry in crucibles in a muffle furnace, the white arsenic comprising the lower layer of the mixture.

Conclusions. 1. Cage and field test data indicate that a specially prepared calcium arsenate containing only 20% arsenic as As_2O_5 is about as effective a boll weevil control as commercial calcium arsenate containing 40% arsenic as As_2O_5.

2. This material may be easily prepared by heating white arsenic and precipitated chalk in the presence of excess air at a temperature of 650°C. for from 15 minutes to 1 hour.

3. It is indicated that the effective percentage of arsenic as As_2O_5 in this special calcium arsenate is between 10 and 20%.

4. Calcium arsenate containing any desired percentage of arsenic as As_2O_5 up to 57.6%—the theoretical for $Ca_3(AsO_4)_2$—may be prepared in the same manner.

5. Other arsenates may be obtained by using the carbonates, or, in some cases, the sulphates of the desired base.

6. The special calcium arsenates so prepared cause no injury to the cotton plant.

ACKNOWLEDGMENT. The Chemical Warfare Service desires to express its appreciation of the assistance and cooperation of the U. S. Department of Agriculture and the various state experiment stations, and especially of the facilities furnished by the respective experiment stations of Georgia, Florida, and South Carolina for this work. In addition to these facilities, we received the heartiest personal cooperation from these sources. H. P. Stuckey, director of the Georgia Experiment Station; Wilmon Newell, director of the State Plant Board of Florida; and H. W. Barre, director of the South Carolina Experiment Station, on all occasions cooperated with the Chemical Warfare Service to the fullest extent. Also, W. E. Hinds, of the Louisiana State Experiment Station, and J. M. Robinson, of the Alabama Experiment Station, conducted field tests with Chemical Warfare Service materials. Our special thanks are due to R. P. Bledsoe, Georgia Experiment Station, E. F. Grossman, Florida Experiment Station, E. D. Kyzer, Clemson Coast Experiment Station, and W. C. Davis, of the Coastal Plains Experiment Station, Tifton, Ga., for their personal efforts.

MR. WILMON NEWELL: The results given in these papers are very significant. I think it is extremely unfortunate that the condition of our program has made necessary such a hasty presentation, and that there is lack of time for proper consideration of these results. They are the most significant developments of many years in connection with the poisoning of the boll weevil.

The Chemical Warfare Service has been exceptionally thorough in its work of investigating poisons under the direction of Congress. Over 1000 possible weevil poisons have been carefully tested and tested with an accuracy that is practically unknown to working entomologists. One of the significant things in this is that the sodium fluosilicate, with only a slight improvement in its mechanical condition, can be used in the future just as well as calcium arsenate for boll weevil poisoning.

I don't have to remind you more than once of the significance of being able to poison the boll weevil with just as high a degree of success with the calcium arsenate, containing 20 per cent of arsenate, as to have to use the old commercial form containing 40 per cent.

Captain Walker's experiments have shown that with calcium arsenate, containing 20 per cent arsenate, made by the method he describes, he gets practically the same killing power as we have been getting with the 40 per cent. Added to those significant points is the fact that either one of these poisons can be manufactured at a cost so low that they can be placed in the hands of the cotton farmer at a much lower cost than can the commercial 40% arsenate. In other words, we need have no fear from now on that there is going to be any difficulty due to a scarcity of commercial calcium arsenate. That bogey is gone, and it is gone for good.

It has been my privilege to observe some of the field tests, especially those at Gainesville, in connection with this work. I want to say the field tests, as measured by the production of cotton, are far more wonderful, convincing and remarkable than are these figures which he has given on the chart. I want to say one thing more, and that is that the Chemical Warfare Service carried out this investigation because Congress told it to. The Chemical Warfare Service is not an agricultural institution. This information has been made public now, and it is for the entomologists and the agricultural workers of the United States to see that it is applied. The Chemical Warfare Service is not going to go out and ask the farmers to use these poisons. The Chemical Warfare Service won't go so far as to urge their use through the agricultural press. Here is a lot of good information. If it is going to be utilized, it is going to be up to you to do it.

MR. H. W. WALKER: I am going to take this opportunity to thank the various experiment stations for their hearty cooperation and I am going to take the time to individually thank the Georgia experiment station, the Alabama experiment station and the Florida experiment station for their hearty cooperation in this problem the last three or four years. There was not a bit of unpleasantness in our relations with the agronomists and entomologists with whom we came in contact. We certainly appreciated this opportunity of working with you gentlemen.

CHAIRMAN G. M. BENTLEY: The next paper is by J. W. Folsom.

CALCIUM ARSENATE AS A CAUSE OF APHIS INFESTATION

By J. W. Folsom, *Bureau of Entomology, Tallulah, La.*

(Withdrawn for publication elsewhere.)

Mr. F. L. Thomas: I would like to ask Dr. Folsom if he noticed any difference in infestation of cotton bollworm where they dust everything with calcium arsenate.

Mr. J. W. Folsom: I don't recall that we made any observations on that. Have you any?

Mr. F. L. Thomas: The past season we had considerable airplane dusting under observation and the cotton bollworms increased rather than decreased when the dust was applied. It seemed to be the opinion of the growers that that was the cause. Fields where no dust was applied had less infestation of the cotton bollworm.

Mr. J. W. Folsom: That might be the same way, but I think that would be a good topic for one of the advanced students to work on.

Chairman G. M. Bentley: The next paper is by R. L. Miller.

BIOLOGICAL CONTROL OF THE GREEN CITRUS APHIS (*APHIS SPIRAECOLA* PATCH) IN FLORIDA

By R. L. Miller, *Ohio State Univ., Columbus, Ohio*

(Withdrawn for publication elsewhere.)

Mr. A. C. Baker: Has Mr. Miller records on the climatic conditions under which his counts of aphid and controlling population were made? I want to know if he can give us the relative influences of such conditions on the development of the respective populations.

Mr. R. L. Miller: Yes. All the data are available. It is all worked out. It will appear in this report.

Chairman G. M. Bentley: The next paper is by Oliver I. Snapp.

A PRELIMINARY REPORT ON THE TOXIC VALUE OF FLUOSILICATES AND ARSENICALS AS TESTED ON THE PLUM CURCULIO

By Oliver I. Snapp, *In Charge, U. S. Peach Insect Laboratory, Fort Valley, Georgia*

Abstract

Sodium fluosilicate without lime, both as dust and at the rate of 2 pounds to 50 gallons of water, was the most toxic to the plum curculio, *Conotrachelus nenuphar*, of all the insecticides tested. That insecticide without lime was also found to be very toxic to peach foliage and fruit. Lime corrected the burning effect of sodium fluosilicate, but these tests showed that lime largely destroyed its toxicity as an insecticide for the plum curculio. Arsenate of lead with lime, either as dust or as a spray, was found to be more toxic to the curculio than any of the insecticides tested except sodium fluosilicate without lime. The relative toxic value of the other insecticides tested against the plum curculio was found to have the following order, the most toxic being placed first: barium arsenate, tricalcium arsenate, zinc arsenate, magnesium arsenate, manganese arsenate, aluminum arsenate, sodium fluosilicate with lime, calcium fluosilicate compound, and scorodite.

The fluosilicates, especially sodium fluosilicate, have now come into rather general use for the control of certain insect pests. Most of the investigations with these new insecticides have been directed against truck and field crop insects, and very little work has been done heretofore with it as a means of controlling deciduous-fruit insects. The effectiveness of the fluosilicates against the Mexican bean beetle, striped cucumber beetle, blister beetle, potato beetle, strawberry weevil, and sugar cane borer, as reported in results of investigations by Marcovitch, Isely, Ingram, Hinds and Spencer, and others prompted the writer to undertake some preliminary tests during the summer of 1927 with sodium fluosilicate and a calcium fluosilicate compound containing 16 per cent calcium fluosilicate against the plum curculio, a serious pest of the peach in the Georgia Peach Belt.

Since the lead arsenate residue problem, now confronting the apple grower, had caused entomologists to test many other chemicals, including the other arsenicals, on apple, in an effort to replace lead arsenate with another effective insecticide for codling moth control, it was decided to use a number of these on peach to observe their comparative effectiveness against the curculio. Thus, tricalcium arsenate, magnesium arsenate, barium arsenate, aluminum arsenate, manganese arsenate, zinc arsenate, scorodite, and arsenate of lead were tested for their effectiveness against the plum curculio in addition to sodium fluosilicate and calcium fluosilicate compound.

Methods Employed

There were 50 tests in all, and each was conducted in a 6-inch x12-inch battery jar. Moist sand was placed in the bottom of the jars, and the tops were covered with thin cheese-cloth. The receptacles for holding in water the peach twigs containing fruit and foliage were small-mouth bottles imbedded in the moist sand. To prevent the beetles from drowning, the stems of the peach twigs were wrapped with cotton so as to fit tightly into the neck of the bottles. A hand sprayer and a hand duster were employed in applying the insecticides, and the fruit and foliage of each twig used in the tests received a through application. The sprayed twigs were allowed to dry before they were placed in the cages containing the adult curculios. In several series of tests the beetles used had emerged from the soil on the day that the tests were started and had done no previous feeding, whereas those used in other series were reared some weeks before and were fed on untreated fruit and foliage until the tests were started. The jars were kept in a shaded insectary, and the thin cheese-cloth tops provided ventilation. Observations for curculio mortality were made in each jar daily or every other day.

Summary of Results

Sodium fluosilicate without lime, both as dust and at the rate of 2 pounds to 50 gallons of water, was the most toxic to the plum curculio of all the insecticides tested. Spraying experiments showed, however, that sodium fluosilicate without lime was also very toxic to peach foliage and fruit. Lime corrected the burning effect of that insecticide, making it even safer than arsenate of lead, but the results of feeding tests showed that lime largely destroyed its toxicity as an insecticide for the plum curculio.[1] With lime the toxic value of sodium fluosilicate as an insecticide for that insect was lowered below that of all the arsenicals tested.

Since sodium fluosilicate has several important advantages over lead arsenate as an insecticide for the plum curculio, it is hoped that this work will prompt others to endeavor to find a buffer for sodium fluosilicate on peach foliage and fruit that will not destroy the insecticidal properties of the material.

Arsenate of lead with lime, either as a dust or as a spray, tested at the strength used by Southern peach growers, was found to be more toxic to the curculio than any of the insecticides tested save sodium fluosilicate without lime, and, except for sodium fluosilicate with lime, it is the safest on peach foliage and fruit. Arsenate of lead at the strength used in these tests is not under normal conditions sufficiently toxic to peach foliage to cause serious defoliation.

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[1] Fleming noted the same results in his work with the Japanese beetle. "Fluosilicates as Insecticides for the Japanese Beetle" by Walter E. Fleming. Jour. Ec. Ent., 20:685–691. 1927.

The relative toxic value of the other insecticides tested against the plum curculio was found to have the following order, the most toxic being placed first: Barium arsenate, tricalcium arsenate, zinc arsenate, magnesium arsenate, manganese arsenate, aluminum arsenate, sodium fluosilicate with lime (both dust and spray), calcium fluosilicate compound, and scorodite.

Scorodite, a natural ferrous arsenate, was found to be practically worthless as an insecticide for the plum curculio.

MR. W. P. FLINT: In this connection I might say to anyone interested in following up this matter of testing fluosilicates against Plum Curculio, during the last three years we have carried on rather extensive tests with many combinations of fluosilicates and various fungicides in Southern Illinois. The results of the tests are published in the proceedings of the Illinois State Horticultural Society for 1926 and 1927. Our results have been about the same as those indicated by Mr. Snapp. We have not had, when we combined fluosilicates with lime, good control of the Plum Curculio. We had practically no control of Codling Moth, getting over 60% infestation in blocks of apples sprayed with calcium and sodium fluosilicate at two pounds to fifty gallons of spray material.

MR. H. W. WALKER: The addition of the lime will unquestionably decompose the sodium silicate and act possibly as sort of a catalytic agent affecting that decomposition. We noticed that with our straight calcium fluosilicate. On actual analysis we never got any such thing. Therefore, we discarded it as a boll weevil poison because it was less toxic to the boll weevil. When it started to decompose it was more toxic to the cotton plant.

MR. S. MARCOVITCH: In my paper, I called attention to the fact that fluorine acts by precipitating calcium from the blood and tissues of the organism. Any addition of calcium will tend to form the insoluble calcium fluoride which is comparatively non-toxic. Hydrated lime will destroy the toxicity of fluorine compounds because their affinity for calcium will have been satisfied in the spray tank rather than in the tissues of the insect.

MR. S. C. CHANDLER: I might make the suggestion that we can't judge from one year's experiments in regard to burning. We carried on some tests to ascertain the burning of arsenate of lead with varying strengths of lime, and, to our surprise the arsenate of lead alone with no lime whatever; showed no injury to peach foliage, though ordinarily we think it is not safe and use lime to prevent burning.

CHAIRMAN G. M. BENTLEY: The next paper is by N. F. Howard.

SOME NOTES ON THE MEXICAN BEAN BEETLE PROBLEM

By NEALE F. HOWARD, *Associate Entomologist, Truck Crop Insect Investigations, Bureau of Entomology, U. S. Dept. of Agriculture*

ABSTRACT

The Mexican bean beetle spread widely in 1927, and reached the province of Ontario, Canada, as well as the great bean producing states of Michigan and New York. It spread further eastward in the Atlantic seaboard states from South Carolina to Pennsylvania. The damage done in 1927 in areas previously infested, establishes this pest as an important one which will require continued effort on the part of the extension and the research entomologist.

Magnesium arsenate or calcium arsenate and lime have proved to be superior to sodium fluosilicate in combating this insect. Analyses of sprayed beans indicate that there is no danger from the use of these poisons when applied as recommended. Native parasites have not aided materially in suppressing this pest in the United States.

DISTRIBUTION

After two years of very slight migration to the northeast, the Mexican bean beetle spread over 150 miles northeastward in 1927, and reached Ontario County, Ontario. The migration to the east in the eastern United States was greater than usual, ranging from 25 miles to over 100 miles, averaging possibly 75 miles from South Carolina to New York State. The spread westward was relatively slight; but the spread northward on the western edge of the infested territory was remarkable, extending as far as Oakland and Macomb Counties in southeastern Michigan. (See Map, Fig. 14).

After two years of relatively light infestations over much of the territory in the southeastern states, the beetle increased in numbers in 1927. As a whole, considering the increased territory involved, this past year from the economic standpoint has probably been the most important bean beetle year to date.

DIRECT CONTROL

Studies of 15 fluorine compounds in 1925, involving a large series of cage tests indicated that sodium fluoride, sodium fluosilicate, barium fluoride, barium fluosilicate, and copper fluoride were the most toxic

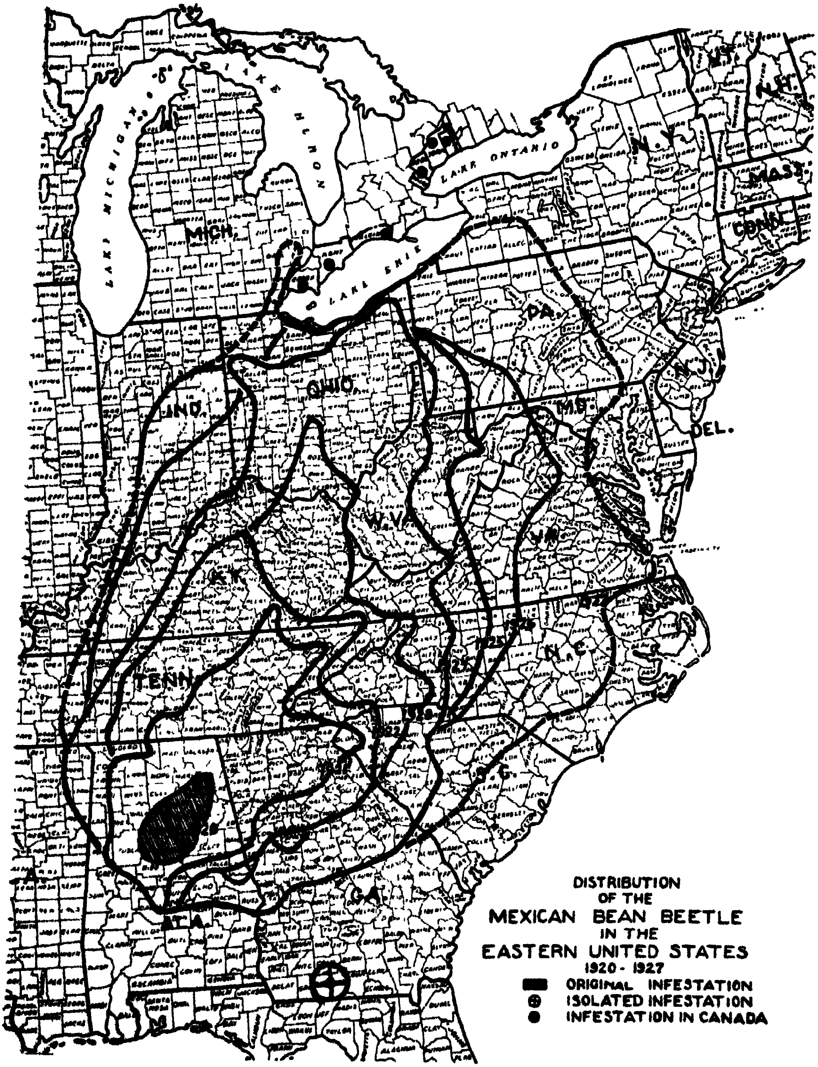

FIG. 14. Map showing the known distribution of the Mexican Bean Beetle in the eastern United States and Canada, December, 1927. The records of spread were obtained through the cooperation of the entomologists in the various states and provinces, and were supplemented in many instances with records of scouting by State and Bureau men. (Original).

to the larvae and adults of the Mexican bean beetle. All of these compounds were injurious to the bean plants in the field except barium fluoride and barium fluosilicate, but these were used in only one field test involving three applications. Sodium fluosilicate received the most attention. The results showed that when this compound was dusted on the plants and the insects placed in the cage, the material did not kill as high percentages as the arsenates of magnesium or calcium used similarly. When the insects themselves were heavily dusted, the sodium fluosilicate killed a higher percentage than the arsenicals men-

COMPARISON OF TOXICITY OF SODIUM SILICOFLUORIDE FROM DIFFERENT SOURCES AND 4 COMMERCIAL ARSENICALS TO THE MEXICAN BEAN BEETLE (CAGE EXPERIMENTS)

Material	No. of Tests	Average Per cent Killed Plants Dusted[1] Beetles	 Plants Dusted[1] Larvae	 Insects Dusted[2] Beetles	 Insects Dusted[2] Larvae
Sodium silicofluoride	3	39			
Sodium silicofluoride	2		30		
Sodium silicofluoride	3			90	90
Sodium silicofloride (sieved 200 mesh)	1			95	90
Sodium silicofluoride (from aother source)	3	36			
Sodium silicofluoride	2		30		
Sodium silicofluoride	3			77	73
Sodium silicofluoride (sieved 200 mesh)	1			85	60
Sodium silicofluoride C. P.	2	44			
Sodium silicofluoride C. P.	1		90		
Sodium silicofluoride C. P.	1			50	65
Average		39	42	83	79
Magnesium arsenate	4	62			
Magnesium arsenate	3		60		
Magnesium arsenate	1			30	55
Calcium arsenate	3	53			
Calcium arsenate	2		70		
Calcium arsenate	1			20	55
Lead arsenate	3	26			
Lead arsenate	2		18		
Lead arsenate	1			50	65
Zinc arsenite	3	48			
Zinc arsenite	2		58		
Zinc arsenite	1			60	65

[1] The plants were first dusted, then the insects were placed in the cage with the plant.

[2] The insects were placed on a flat wire screen and dusted thoroughly and then placed in a cage with an untreated plant. 20 insects were used in each test with a few exceptions, when 10 were used.

tioned. (See Table.) Results of numerous field tests during the past three years, indicate that the superiority of the arsenates of magnesium and calcium (used with lime) for bean beetle control is marked. This is no doubt due to the physical properties of the sodium fluosilicate now available and the resulting poor residual effect due to poor sticking properties. As for freedom from plant injury, the superiority of the arsenicals mentioned is even more marked.

Plant injury from the use of sodium fluosilicate is decreased by the addition of hydrated lime but toxicity to the insect is also decreased. In field tests in 1926, bentonite and diatomaceous earth were used as diluents (2 parts to 1 part of sodium fluosilicate) in comparison with hydrated lime, used in the same proportions by weight.

The bentonite mixture gave poorer control than the lime mixture; the diatomaceous earth mixture gave the same degree of insect control and plant injury as the lime mixture.

Numerous tests during the past three years have shown that a calcium fluosilicate compound is too low in toxicity to be of practical use when the infestation is heavy unless excessive amounts are applied.

Pyrethrum and pyrethrum extracts have been tried rather extensively. Both are very toxic to the beetle and the larva. The extract may be diluted 5 to 8 times more than recommended for the Japanese beetle, but when used in the field under conditions of heavy infestation, poor control was obtained when 5 applications were made a week apart. This is probably due to the absence of a toxic residue shortly after application. The compound has value, however, in that it can no doubt be used after the bean blossoms by those who refuse to use an arsenical on green beans.

The problem of the control of the Mexican bean beetle, is one which requires considerable assistance from the extension entomologist and the county agricultural agent. So many compounds are sold locally, some of doubtful merit, that the grower needs advice on the choice of materials. The necessity of reaching the undersides of the leaves, whatever material is applied, is one that is not always appreciated by the grower.

In the southeastern states where three or four broods of the beetle occur, the date of planting to avoid injury is not always important. But further north where only two broods, or two broods and a small third brood develop, a proportion of the bean crop may be planted late enough to escape the majority of overwintered females and thus avoid considerable injury. When planting is delayed in southern Ohio until middle or late June fewer dust or spray applications are required.

The importance of clean up practices when the infestation is heavy cannot be over emphasized. A crop of bush beans may have an adult population of 3 million adults to the acre and several times as many of the immature stages. Pole beans may have a much higher population The benefit derived from plowing under or otherwise destroying this large number of insects is obvious.

ARSENICAL RESIDUE

Beans which were sprayed with arsenicals in accordance with recommended practices, were run through the cannery in the normal manner, and then analyzed. The highest arsenical content was .001 grains per pound in two instances and others ran far lower.

A large number of samples of sprayed and dusted beans from our experimental plats have been analyzed by the Food, Drug and Insecticide laboratory of the United States Department of Agriculture. These samples were not washed, it being desired to have data on extreme cases. Some of the samples picked immediately or within three days after treatment showed more than .01 grains per pound, but a portion of these had been treated with heavy dosages for the purpose of obtaining experimental data. In rinsing and cooking the arsenic content would have been greatly reduced. There has been no indication, on the basis of numerous analyses of treated beans, that the recommendations for controlling the bean beetle, if followed carefully, are dangerous from the standpoint of arsenical residue.

NATURAL ENEMIES

During the seven years that the Mexican bean beetle has been present in the southeastern states, very little assistance in suppressing it has been given by parasites and predators. The potential value of at least one parasite in Mexico, the tachinid fly, *Paradexodes epilachnae* Ald., is great, and further efforts to introduce this species should be made.

CHAIRMAN G. M. BENLTEY: The next paper is by D. M. De Long.

SOME OBSERVATIONS UPON THE BIOLOGY AND CONTROL OF THE POTATO LEAFHOPPER (*EMPOASCA FABAE* HARRIS)

By D. M. DeLong.[1] *Columbus, Ohio, Bureau of Entomology,*
U. S. Dept. of Agriculture

ABSTRACT

The potato leafhopper, *Empoasca fabae*, under natural conditions in the field is able to complete its life cycle upon a number of wild and cultivated host plants. The type of injury is specific for different plants. In Ohio the bush bean seems to be the early preferred cultivated host. Eggs are laid in the field as early as May 20 on beans. The adults do not migrate to potato until about one month later. Four distinct seasonal broods have been reared during 1926 and 1927. Preoviposition period for 90 pairs in two seasons gave an average of slightly over six days. The average incubation period was 9.9 days. One mating is sufficient for the life of the normal female. Control on bean was most easily accomplished by oleo resin of pyrethrum extract, Japanese beetle formula, but this may be diluted to a 1 to 300 strength and still give economic control.

Several entomologists and groups of workers have carried on investigations with the potato leafhopper, *Empoasca fabae*, during the past few years, but in every case upon record this work was performed with emphasis upon the insect's relationship to a specific plant or crop. In some cases the emphasis has been so striking that the investigator failed apparently to see the biologic relationship to crops and plants in general, such as spring host preference, seasonal sequence and many other problems of a similar nature.

Although the present investigation was carried on with reference to the stringless green pod bean plant as a host, field observations were constantly made upon the available truck crops, field crops, fruits and weeds to determine seasonal occurrence and abundance as well as choice of foods. The present report is not in any sense a completed record of this leafhopper's activity but is an attempt to study the insect in the field where a choice or preference is shown for plants as food or for deposition of eggs and apparently does throw some light upon the different results secured by various workers.

This leafhopper has been observed to pass its life cycle under natural conditions, upon a great variety of wild and cultivated plants including the common dock, and such cultivated plants as bean, potato, egg plant, rhubarb, clover, alfalfa and the apple, as well as several ornamentals.

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[1] Professor of Entomology, Ohio State University. This work was performed while employed as Field Assistant on the Mexican Bean Beetle Project, Truck Crop Insect Investigations, Bureau of Entomology, U. S. D. A.

Upon most of these severe economic damage may occur although the type of injury is specific for different plants. The hopperburn condition is very characteristic upon potato, egg plant and rhubarb. Stunting and dwarfing are common types of injury on the bean. The tight curling of the leaves or rosette condition is noticed upon the bean and occasionally on the apple while such plants as clover and alfalfa show a reddening or yellowing condition as has been indicated by other workers.

As the insects come from hibernating quarters in the spring certain types of plants seem to be preferred as hosts. These hoppers are found feeding very early upon many of the wild succulent plants but among the cultivated crops the bush bean seems to be the early preference of the greater portion of the population, upon a large scale. During 1927 they were found in abundance upon bean as early as May 20 and began laying eggs at about this time in the field. The first eggs were hatching on June 6 and 7, and the insects emerged as first generation adults June 25. This condition prevailed upon all early planted beans over a large area. On the other hand early potatoes in large acreage and diverse locations which were above ground before the beans, were not infested at this time and only an occasional adult could be found after long search. The adults did not migrate to potato during this season until June 21 and 22 at which time the first individuals reared upon bean in the field were becoming mature. This undoubtedly corresponds to what Fenton and Hartzell called the spring flight. The first record of actual emergence from beans was on June 24 and 25 in the field and on June 25 in the insectary.

Life history studies have revealed four distinct broods of these leaf hoppers during the season with one complete generation, a second almost complete, a partial third and a smaller partial fourth generation. The generations overlap greatly and there is no definite break in infestation upon bean plants in the field at any particular time except when the beans begin to age and the hoppers consequently seek younger plants.

Under field conditions during 1927 the first eggs were laid about May 25, and on November 1 eggs were still hatching. Adults and second, third and fourth instar nymphs were still present on rhubarb in the field on December 1 after a minimum temperature of 25°F had occurred. So long as temperature and other conditions remain favorable for development and activity, the adults of a given generation behave similarly to the adults of any other generation since they immediately mate and begin egg laying. When late adults of the first generation, adults of the second and early adults of the third generations were mated on the same day, viable eggs were laid by each of these females at the same time. Experiments carried on with potato as a host plant indicate that the same conditions as regards incubation, preoviposition and the time required for development occur upon this plant as upon the bean.

From the important economic standpoint the number of technical, completed generations is not as important to the farmer as is the accumulated number of hoppers in the field, owing to this rapid development and reproduction of overlapping broods. For this reason the economic status of the individual female depends entirely upon her seasonal occurrence and her consequent ability to further reproduce during the season rather than upon the generation to which she may belong.

PREOVIPOSITION

Other scientific factors enter into the economic consideration of the insect in the field. All records of preoviposition previously reported or published were based upon records of small numbers of adults and showed preoviposition periods of from 20 to 30 days.

During the seasons of 1926 and 1927 ninety pairs of *Empoasca fabae*, reared from all generations, were observed to determine the preoviposition period. Forty pairs were observed in 1926 with an average preoviposition period of 6.2 days. Fifty pairs under observation in 1927 gave 6.1 days as the average preoviposition period. This includes all of the longer records and several minimum records of four days. The adults of the first seasonal brood in 1927 showed an average preoviposition period of 4.9 days, the adults of the second brood an average of 6.4 days and the adults of the third brood an average of 6.9 days.

INCUBATION

From data of these two seasons the incubation period is shown to vary considerably, but there is a surprisingly definite correlation between temperature and the number of days required for hatching. For 1,940 observations on incubation in 1926, the minimum incubation period was 7 days, the maximum, during the coldest period in autumn, was 19 days, with an average for the 1,940 observations of 9.9 days. The average incubation period for the important growing season during June, July and August is less than 9 days.

NYMPHAL DEVELOPMENT

Under normal summer conditions the nymphal development is very rapid. For the first and second broods in 1926 the average number of days from hatching to the adult stage was slightly over 12. For the third brood the number was 14.4 days while the fourth brood required 22 days from hatching to maturity in 1926.

On the basis of these figures it may be seen that during June, July and August it normally requires slightly less than a month on the average, from the time an adult emerges until its first progeny has reached the adult stage.

MATING

All observations which have been made to date tend to prove that mating is necessary for the production of fertile eggs. Mating normally takes place within two or three days after emergence and one fertilization is sufficient for the normal life of a female. Apparently additional fertilization, where the male is retained with the female, does not affect the numbers of eggs produced.

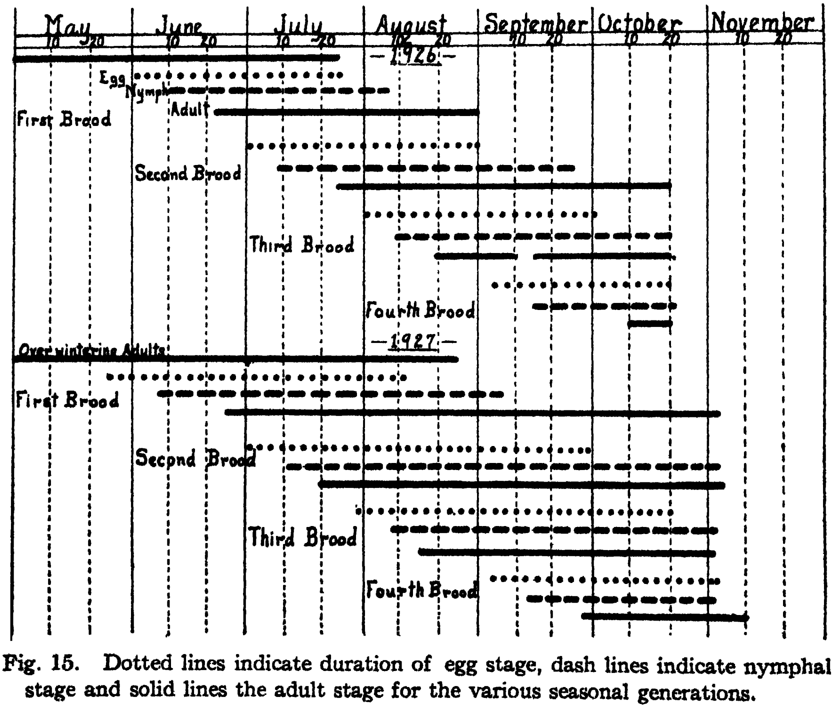

Fig. 15. Dotted lines indicate duration of egg stage, dash lines indicate nymphal stage and solid lines the adult stage for the various seasonal generations.

LONGEVITY

No records are available for the length of life of an adult in the field. Under cage conditions the average longevity was 30 or 40 days while much longer records have been obtained. During the season of 1927 one female which had apparently overwintered was collected in the field on May 25 and died on August 25, living in captivity for 92 days and producing 198 fertile eggs during this period. This female was not mated in captivity. A female reared to the adult stage on June 29 was mated and lived until September 28, or 91 days, producing at least 216 fertile eggs. This record was not complete as a few plants which apparently contained fertile eggs died, and the eggs did not hatch.

INDIVIDUAL EGG RECORDS

It is practically impossible to determine the total number of eggs deposited and the percentage which hatch, in view of the fact that these are inserted in plant tissues and will not hatch if dissected out. Observations for rather long periods upon a large number of females indicate that there is a wide variation in the number of eggs deposited by individuals. The great majority show an average of two or three eggs per day. The highest record was obtained from a female which laid 226 eggs in 47 days, giving an average of 4.8 eggs per day.

CONTROL

A large variety of insecticides have been given comparative tests in plot work during the past two seasons. A number of these were of little or no value as controls. Such materials as a commercial white oil emulsion 2%, a cocoanut fatty acid emulsion, a commercial derris product 1–250, and the fluosilicates in either wet or dry form, proved unsatisfactory. Even nicotine at a dilution of 1 to 800, in combination with soap or oil did not give sufficient control to warrant its recommendation. The standard sprays of Bordeaux 3–6–50 and 4–6–50 proved satisfactory for the control of the leafhopper but it is still doubtful if this material can be used upon the bean plant under varied conditions without causing foliage injury, especially when lead arsenate is added. Although other factors entered into the experiment, preliminary tests with monohydrated copper dust gave very promising results.

As a dust most satisfactory results were obtained by applications of a 40 to 50% calcium cyanide and no chemical injury has been noted to date. As a spray the most satisfactory results were obtained both seasons by the use of pyrethrum extracts. In certain forms and dilutions these extracts paralyze both adults and immature leafhoppers within a few seconds. No other treatment, either spray or dust, was found which killed adults as did this material. Although the insect sometimes lived for several hours it did not regain control of its locomotive appendages and consequently, from the economic point of view, was as good as dead. The oleo resin of pyrethrum extract which has been used for the Japanese beetle has proven very satisfactory and can be used for the leafhopper at dilutions as high as 1 to 300. On plots thus treated no nymphs could be found upon examination 1 hour and 24 hours afterwards while the adjoining check plots showed an average of more than 50 to the plant. This material is apparently not of economic value as an ovicide. Pyrethrum extract combined with a commercial miscible oil gave practically the same results and proved to be a much cheaper spray.

Mr. S. Marcovitch: I would like to ask if he tried sulphur.

Mr. D. M. De Long: Not for the leaf hopper control.

Mr. Albert Hartzell: Some recent experiments with this species under controlled temperature and humidity conditions indicate that the length of time it takes to complete a generation varies greatly with the temperature used. For example, at a constant temperature of 78 degrees Fahrenheit and a relative humidity of 80 per cent, the period from egg to adult may be reduced to 18 days. This response to slight changes in temperature may explain in a measure the conflicting reports in the literature.

Chairman G. M. Bentley: The next paper is by F. W. Poos and H. S. Peters.

INVESTIGATION OF THE POTATO TUBERWORM, *PHTHORIMAEAE OPERCULELLA* ZELL., IN VIRGINIA DURING 1926 AND 1927

By F. W. Poos and H. S. Peters, *Virginia Truck Experiment Station, Norfolk, Va.*

(Withdrawn for publication elsewhere.)

Chairman G. M. Bentley: We will now take up a paper by A. C. Morgan and S. C. Lyon.

NOTES ON AMYL SALICYLATE AS AN ATTRAHENT TO THE TOBACCO HORNWORM MOTH

By A. C. Morgan and S. C. Lyon, *Clarksville, Tenn.*

Abstract

Amyl salicylate incites a decided feeding response in tobacco hornworm moths, (*Phlegethontius carolina*), inducing a natural attraction to artificial flowers. Large numbers of tobacco moths and other Sphingidae were caught in traps baited with amyl salicylate. Amyl benzoate is also very attractive.

For a number of years experimental work has been undertaken at the Clarksville, Tennessee, Laboratory of the Bureau of Entomology, U. S. Department of Agriculture, in an attempt to discover a chemical attractive to the tobacco hornworm moth. Previous to the season 1925, efforts were made to obtain the odorous principle of the Jimson weed flower, a preferred source of food of the moths, by distillation, extraction, and other methods, but with little or no success. During the summer of 1925 this work was continued, using an enflueragc process, but with only slightly successful results. In the meanwhile additional chemical substances were tested to discover an artificial substitute for the natural fragrance of the flower. Over forty aromatic oils and etherial salts that seemed to offer possibilities as judged by human standards were successively tested. Among these substances benzyl benzoate was the first to produce a mildly posititive reaction. Finally, amyl salicylate was observed to induce a pronounced feeding response on the part of the moths.

The preliminary laboratory experiments were conducted in an especially designed cage which induced a reasonably normal activity of the moths. Substances to be tested were supplied in various ways and the reactions of the moths during the active period of the early night were observed. In noting the responses of the moths to the substances tried, no visit of the moth to a baited or check station was counted unless the moth actually hovered over the apparatus or circled around it, obviously in an effort to locate food material. Frequently, in such a response, the tongue was observed to be unrolled, and if a petri dish containing sugar sweetened water was included in the set up, actual feeding for a period of time often resulted. The next step was the construction of an artificial Jimson weed plant bearing paper blossoms. Under actual testing conditions each of the artificial blossoms was touched with a cotton swab saturated with amyl salicylate. The artificial plant was exposed in the open field and the result was that more moths were attracted to it than to a greater number of natural blossoms in a nearby patch of Jimson weed.

During the season of 1926 efforts were made to design effective traps for hornworm moths to be used in connection with the attrahent. In all, about fifteen different types and sizes of cages were made and tested. In general, most of the traps were a modified type of house-fly trap built on a large scale, using wire screen over light framing. In some, access could be had from all four sides; in others, from only one or two sides. In all cases, exit from the traps was prevented by a baffle screen just within and above the entrance. In baiting the traps, strips of black cloth were used to avoid any possible reaction of the moths to color. These cloths were greased with benzoated lard before being impregnated with amyl salicylate in order that the odor would be slowly released. The treated cloths were suspended on wires opposite the entrance, which was usually near the bottom of the trap. Small funnels painted white were used to simulate Jimson weed blossoms.

In the field tests eight locations were selected for the traps and the catch was recorded daily. Seven of these tests were individual traps and were placed at intervals of about one mile to avoid interference. The eighth location was a 16-acre tobacco field, in and around which were placed six baited traps. The seasonal catch of tobacco moths at the different single-trap stations was as follows: 267, 729, 726, 895, 887, 925, 389. A total of 2,194 moths were taken at the six-trap station in the tobacco field. The catch of moths in the 16-acre tobacco field contained enough newly emerged females to have deposited an average of 8.5 eggs to the plant under normal oviposition conditions. The infestation of the trapped field, however, averaged only 2.63 eggs and worms per plant, while the surrounding check fields averaged 6.67 eggs and worms per plant. In 1926 this field experiment was repeated on the same farm, using eight traps on 8 acres. In this experience the funnels simulating Jimson weed blossoms were omitted, and the odor was distributed from a lamp wick immersed in a vial of amyl salicylate. The infestation of the trapped field from July 29 to September 1 averaged 4.1 eggs and worms per plant, while the check field averaged 6.3 eggs and worms per plant. A number of female moths sufficient to have deposited 8.1 eggs per plant were caught in the trapped field.

Sixteen species of Sphingidae were caught in the traps in addition to the two species frequenting tobacco. Only two non-tobacco feeding species, *Xylophanes tersa* Linn. and *Celerio lineata* Fabr., were caught in numbers.

It might be of interest to record here that in a series of preliminary field experiments where amyl benzoate was substituted for amyl salicylate, the indications were that this chemical would prove even more attractive to the tobacco hornworm moths than the amyl salicylate.

CHAIRMAN G. M. BENTLEY: The next paper is by L. Haseman.

TARNISHED PLANT BUG INJURY TO STRAWBERRIES

By L. HASEMAN, *University of Missouri, Columbia, Mo.*

ABSTRACT

Following the severe freeze in the spring of 1927 the late crop of blossoms and developing strawberries in several fields in Southwest Missouri suffered severely from the tarnished plant bug, *Lygus pratensis* In some fields the entire crop was a loss The first brood of developing nymphs caused the damage before May 10. To prevent similar damage the grower is advised to keep weeds cut during the summer and fall, burn over winter harbors, make sure the winter mulch does not harbor the bugs, and if adults appear on the crop early in the spring drive them out or destroy the young nymphs with nicotine spray or dust.

Last spring the strawberry growing section in Southwest Missouri experienced a very severe frost after strawberries had begun to bloom. Which gave the crop a set-back, though as records of sales showed later it did not seriously affect the value of the crop. As a result of the frost the berry crop came largely from late blossoms. In some fields, associated with the set-back appeared the most severe injury the writer has ever known the tarnished plant bug to cause. In some fields visited on May 10, practically one hundred per cent of the crop was destroyed by the bugs. The growers had just begun to pick and on the worst infested fields there were not enough berries to pay to go over them. Only an occasional berry from early blossoms which the frost missed seemed to have escaped the bugs.

NATURE OF INJURY. The usual injury to berries results in what the grower calls "buttoning" and every year more or less of this occurs. In these fields every berry in the clusters was affected. In place of simply stunting the tip of the berries the entire berry was blighted. When affected their growth stopped and they had a dead woody texture. The pest confined its feeding to the berries as the foliage and crowns were perfectly normal.

NYMPHS CAUSED INJURY. As a rule where the tarnished plant bug injures a plant it is due to the feeding of the adults. The stop-back injury to nursery stock is the work of the adults and the usual "buttoning" of strawberries is largely their work. In this case, however, adults were very scarce while half a dozen half-grown nymphs were present on some clusters of berries. The blighting effect was done between May 1 and May 10 and was undoubtedly caused largely by the early brood of nymphs.

INJURY WORSE IN SOME FIELDS. As shown in the writer's earlier study of the tarnished plant bug as a pest of nursery stock, the pest spends the winter as the adult in various favorable harbors, and is attracted largely to the blossoms of weeds and other plants for ovipositing. In the same neighborhood some fields of berries were an almost complete loss while others showed but little injury. The worst infested field was near a hedge row with meadow on two sides and the patch was heavily mulched with straw. Some of the adults probably passed the winter in the mulch but undoubtedly the hedge was the principal harbor. The strawberries proved to be the most attractive available vegetation and with their late crop of blossoms as an added attraction for oviposition, the bugs flocked to the nearest patches for feeding and breeding.

This is not the first year that the pest has done such serious damage in this part of the strawberry belt, but it was the writer's first opportunity of seeing a complete loss of crop by the pest.

CONTROL MEASURES POSSIBLE. The most practical control measure for this pest under ordinary conditions is the destruction of all favorable blooming weeds, such as *Erigeron canadensis*, wild asters, and similar plants during the late summer and fall to reduce breeding and the destructon of all favorable winter harbors. In the strawberry belt this is the grower's first and most practical remedy. Along with this should be used a method of mulching which will not protect the pest during the winter. Where, in early spring, the adults appear in large numbers they can be driven with the wind when the mulch is drawn away from the berry rows. Anything that can be done to prevent the adults from ovipositing on the plants will help to save damage to the crop later.

Where the pest succeeds in breeding in large numbers on the blossoms and young berries prompt applications of nicotine spray or dust, while expensive, may be used to help save the crop. The pest was unusually abundant in central Missouri on flowers during October and early November, and our strawberry growers may expect trouble again next spring unless they take steps to protect the crop.

CHAIRMAN G. M. BENTLEY: I might say that among the nursery interests in Tennessee we find the setback to the peaches is frequently very bad from this insect. With the strawberry, which is of no small interest in Tennessee, we have not found any. To me, Mr. Haseman, the paper was very interesting because we will watch the Mississippi

Valley in Tennessee. It seems to me the conditions would be very similar.

President R. W. Harned resumed the Chair.

PRESIDENT R. W. HARNED: The next paper is by W. E. Hinds and Herbert Spencer.

INSECTICIDAL CONTROL FOR THE SUGARCANE BORER

By W. E. HINDS and HERBERT SPENCER, *Baton Rouge, Louisiana*

ABSTRACT

The work of three seasons at the Louisiana Experiment Station has yielded consistent results showing that it is possible with a water-soluble dust like sodium silicofluoride to destroy at least half of the sugarcane borer larvae occurring on the exterior or burrowing through the interior of the stalks of corn or sugarcane which are the principal host plants of this species in Louisiana. With many of the more than fifty (50) materials tested thus far there has been a degree of burning of foliage of corn which is serious, but on cane which is much more resistant to chemical burn, a number of materials have been found safe and effective enough to justify extensive field applications which may at least supplement other measures in controlling this pest.

During the past three seasons the entomologists of the Louisiana Experiment Station have been securing quite consistent and encouraging results from the use of dusts of sodium and some other silicofluorides (or as they are often called also fluosilicates) in controlling the sugarcane borer. This insect feeds for a time in the leaf-roll of its host plant then later bores into the stalk making usually three or more borings in the course of its development. It has not been found controllable by insecticidal applications of arsenicals. Therefore when it is found possible to destroy quite regularly from forty (40) to over seventy (70%) per cent of the larval stages, without affecting seriously the growth of the cane or the yield of sugar, we consider the results "decidedly encouraging."

In this work applications have been made by hand dusters and by mule-drawn, traction machines during the first half of the season before the cane exceeds six feet in height. During the latter part of the season it becomes impossible to get through the rows with any such machines and the dusting airplane has proven to be the only usable method. Treatments have been applied on several varieties of corn, sorghum, etc., and to many varieties of cane. From one to nine applications have been made on the same areas and the poundage in these applications has ranged from five up to fifty-two (52) pounds per acre.

Mortality records are based upon the larval stage only as the effect upon pupal and other stages cannot be expected to be an important factor in control. There is a small percentage of kill among pupae, but eggs appear to be practically unaffected, although further close work is needed to settle this point positively. It may prove to be fortunate that borer eggs are so little affected as thereby the very important Trichogramma egg parasites are also protected and emerge apparently without increase in the percentage of mortality which occurs naturally within the borer eggs. This incidental relationship to Trichogramma development is extremely important and affects greatly our general conclusions as to the value or advisability of any insecticidal applications for borer control.

In determining the net results from insecticide applications and also the best time for making any such applications, it is now evident that the percentage of borer eggs parasitized by Trichogramma should also be considered as it affects directly and probably even more than the insecticide may do, the total borer population developed in the field and subsequent injury to the cane. We believe that the insecticidal application made at the proper time and with the best materials known, constitutes a needed supplement to natural control.

Trichogramma attack on borer eggs is negligible until the third generation of borers starts and then increases and becomes decidedly effective during the fourth and fifth borer generations. It would appear therefore that insecticidal applications may be especially important early in the season before parasite control becomes effective or at any time through the season when the Trichogramma infestation is below seventy-five (75) or eighty (80%) per cent. During the fall of 1927 when this infestation ran often above ninety-five per cent (95%), dust applications appeared to be less helpful or advisable.

During 1927 a number of manufacturers of silicofluoride materials cooperated with the Louisiana Experiment Station by preparing sample lots of new materials or mixtures of materials for our field testing work. More than fifty (50) different samples were thus prepared and tested first on corn and the best of them then applied to cane. Physical qualities, insecticidal efficiency and safety to foliage have been considered principally in comparison with the best materials previously used. In this work it has been found that the inclusion of 5% of hydrated lime has as much effect in reducing the burning of foliage as does 10% and the lower amount is advisable from the standpoint of securing somewhat greater insecticidal efficiency. There is a plain difference between cane varieties in their susceptibility to burning of foliage but practically no danger of injuring the eyes of any variety. The most serious type of burn is seen in an irregular "splotched" or bleached appearance on the blade of matured leaves which is evidently due to the effect upon the chlorophyl. This does not occur often upon young cane or upon the most tender growing leaves. These are often called the "whorl" or "bud leaves" and occur at the top of the plant. These top leaves have greatest functional value in the growth of the plant. The leaves which show bleaching are those which have fully matured and have begun to break down. This stage of maturity of the leaf is accompanied by a loosening of the leaf-sheath from the stalk of the cane. In due time the lower leaves thus mature, loosen, and dry-up completely normally. Sodium silicofluoride applications appear to hasten this maturity and decomposition of cane leaves but do not check the growth of the cane in ordinary applications and with most varieties of cane.

Rainfall of over one inch falling immediately after a dust application does not prevent the killing of nearly a normal fifty (50) to sixty (60%) per cent of the larvae present. Rainfall appears to hasten the killing effect which is more gradual and continues over a longer period when no rains occur.

Natural mortality is undoubtedly heavy among newly hatched larvae. These first stage larvae are so small, die so quickly and disappear so nearly completely that they constitute a very minor fraction in the mortality records. Among the thousands of larval stages taken from undusted cane only from two (2) to four (4%) per cent have been found dead. This small percentage should be deducted from the total mortality records as recorded for dusting tests.

Sodium silicofluoride has both contact and stomach poison effects. Few borer larvae, whether just hatched or fully grown, will survive to crawl more than eighteen (18) inches over a lightly dusted surface. Most of the larvae thus killed on the exterior will be lost off after a few days and never recorded in examinations. The "peak of mortality." is usually reached in from five (5) to seven (7) days after dusting. The killing effect decreases gradually but continues for more than fifteen (15) days and in spite of rainfall totalling over three (3) inches meantime. In examinations of dusted cane many fresh shallow burrows are found without larvae present and the natural inference is that many larvae are poisoned in such burrows which they then leave. Some of these larvae are probably among those which are found dead on the exterior of the stalks, and it is equally probable that others are lost off in the course of events through rains, winds, growth of the plant and the process of cutting and handling the stalks which are examined. Fewer living larvae would be removed from the record in these ways. Even the records made in from five (5) to seven (7) days after dusting lose track of some of the first killed larvae and, obviously, cannot include the mortality which might occur during the next week or more if the stalks were left undistrubed. For these reasons especially it is certain that all records of mortality which can be secured are exceedingly conservative and represent only a part of that which actually occurs in dusted fields.

The percentage of mortality among borers is also influenced strongly by the poundage of dust applied. In 1926 work an average of records from applications of ten (10) pounds per acre showed a mortality of twenty-five (25%) per cent while eighteen (18) pounds per acre gave forty-two (42%) per cent killed.

The final records of the effects of poison applications are complicated further by the development of subsequent generations and by the activity of *Trichogramma minutum* which may destroy a large proportion of the borer eggs laid after the first of September. Five generations of borers were produced in 1926 and a partial sixth generation in 1927 in central Louisiana. The burrows made by larvae of all of these generations accumulate in the stalks up to the time of harvest and must be counted together in the final records showing the percentage of joints bored. The final results of dusting were shown more clearly in 1926 with a lighter borer attack and a lower percentage of egg parasitism and when the dust was applied about six (6) weeks before harvest than was the case in 1927. In 1926 work an average of dusted areas showed that twelve (12%) per cent of the joints had been bored while in carefully chosen check areas the average was twenty-six (26%) per cent.

In treating cane fields with the material used thus far, we find that a plane of good capacity should treat on the average at least two hundred (200) acres per hour with twenty (20) pounds per acre. The "effective dust swath" width with most silicofluoride materials is about one hundred (100) ft. It is preferable to treat the cane while the foliage is dry but if necessary to work while the dew is heavy, the planes should fly higher to allow the dust cloud to spread more widely before it reaches the cane leaves. There is no danger of poisoning farm animals from the drift of dust onto foliage of forage crops or pastures.

The work of the Louisiana Experiment Station in the insecticidal control of the sugarcane borer has given quite consistent and encouraging results during the past three seasons.

Improvements in materials seem possible and probable. Several of the new mixtures used in 1927 killed from forty (40) to over fifty (50%) per cent of all larval stages in an average of all examinations made for each dust. These examinations included stalks taken along the middle and an equal number taken from an outer edge of each dust swath. These lines or rows were marked at the time of dusting. Several examinations were made on each dusted area and ranged in most cases from the 4th to the 19th days after dusting. The figures therefore show an average of all percentages found for six (6) or eight (8) examinations made during a period of from two (2) to three (3) weeks time and not just what might occur when the "peak of mortality" was reached.

Insecticidal applications do not seem to affect unfavorably the development or activity of the Trichogramma egg parasite. In 1927 the work of this parasite was most effective from June to November in a cut of cane where laboratory bred Trichogrammas were colonized in June and where two applications of dust were made during the first weeks of August and September. This reached very nearly 98% of the borer eggs parasitized by September 20. There is no other important parasite of the borer in Louisiana.

The killing of such stalk-boring caterpillars as the sugarcane borer has been proven possible and may in due time be found practicable and advisable along with the practice of other measures for the control of the sugarcane borer.

MR. N. F. HOWARD: With how many applications did you seem to get the best results in using this for the cane borer?

MR. W. E. HINDS: It is hard to say. Some of our work started early in the season and continued as long as it was possible for us to run through the cane fields. That ran up to about the last of July. The heavier infestation comes during August as a rule. It increases rapidly at that time. Hitherto we have considered that application at about that time should have the greatest insecticidal efficiency. It looks now as though application in July followed by the high percentage of Trichogramma later in the season might be the best—possibly not more than two or three applications during the season.

MR. L. O. HOWARD: Have you tried it on corn?

MR. W. E. HINDS: The burning of the silicofluoride on corn foliage is too severe to make it a practical field recommendation, but the killing in corn may range up to 65 or 70 per cent.

Mr. W. W. Stanley: How many pounds per acre?

Mr. W. E. Hinds: The best control results are usually 18 to 20 pounds. Below 10 pounds the percentage of kill is only about two-thirds what we get with the higher application. Oftentimes the larvae work up instead of down. Where it is working up and does not go down, we have very little chance.

President R. W. Harned: The next paper is by W. O. Hollister.

INJECTION EXPERIMENTS FOR CONTROLLING INSECTS

By W. O. Hollister and H. L. Jacobs, *The Davey Tree Expert Co., Kent, Ohio*

Abstract

This paper discusses the methods, apparatus and materials used in injection experiments in an attempt to control borers. Allusion is made to materials used in 1926. Aloes, Aloin, Thymol and Acid fuchsin were used in 1927 with varying effects on the trees. As far as the borers were concerned, the results were all negative.

In 1926 one hundred and eighty-four trees were injected with some twenty-eight different materials to determine if certain diseases and insects could be controlled by this method. The full procedure was discussed by Scherer in a paper read before the American Pathological Society at Philadelphia last December. An abstract appeared in Phytopathology Vol. 17, No. 12.

This year these experiments were continued with the same two factors in mind. First, trying to find materials which are toxic to fungi or insects and second, materials which are toxic to the pest and not toxic to the tree. These two factors are, of course, always present when any new insecticide is under consideration.

In 1926 all solutions were injected by a cumbersome system of gravity pressure by means of tanks suspended in the top of the tree or in the nearest available tree. This method necessitated much climbing and the tanks could not be watched carefully.

This year all injections were made by pressure from a compressed air tank. A special portable brass tank was fitted up which permitted a pressure of from one to eighty pounds per square inch. A water gage of 100cc graduation permitted accurate readings of the amount of liquid used. Thick walled flexible rubber tubing which withstands fifty pounds pressure was used for nearly all of the injections. For special occasions a heavier hose was used. A special clamp was developed for holding the connection to the trees.

In making a connection for the injection a hole was bored in the tree from 2″ to 4″ deep. This permitted the liquid to be taken up by the sapwood. The nipple is inserted in the hole, the air cleared from the tubing and the hole filled with the solution before the connection is tightened. This gives an unbroken column of solution from the tank to the sapwood. The pressure to use and the amount of materials can only be determined by experience.

In 1926 Arsenic Trio ide, Bayer Compound, Black Leaf 40 and Strychnine Sulphate were used in white birch trees for bronze birch borers. These materials were used at various strengths with more or less injury to the trees and all results were negative as far as the borers were concerned. As high as two pounds of strychnine were injected into a 23 inch tree without injury to the tree or the borers. In all twenty-five pounds of this material were used in these experiments. Forty gallons of solution were injected into a tree in one afternoon. Strychnine sulphate was also used in an attempt to control the elm bark louse (*Gossyparia spuria*) but without effect.

The materials used this year were four, Thymol, Acid fuchsin, Aloes and Aloin. Thymol, a powerful irritant, was used at a strength of 1–1250 on July 25th. Investigation showed the presence of borers. One small 2¾ inch tree received 4600cc of thymol solution. On August 1st a few of the leaves showed injury. On September 21st bark was removed from the trunk and large live feeding borers were found.

Acid fuchsin, an aniline dye, a germicide in medicine, was used because it travelled so rapidly in chestnut and apple, spreading and coloring the wood and leaves. Two grams were injected into a 5 inch tree until the leaves over the lower part of the tree showed a stain and there was color in the pith but none in the sapwood. On September 7th none of the stain showed in the leaves altho those which were stained when the injection was made were dead. Live feeding borers were found at the edge of the injection hole which had been stained by the dye.

Aloin is refined from aloes, a crude vegetable drug, of which aloin is the active medicinal agent. It is very bitter and is used as a cathartic. The strength of solutions used were 1–1000, 1–200 and 1–150. One to one hundred fifty is nearly a saturated solution. Most of these trees were first injected during April and May before the beetles emerged and the new brood of larvae started feeding. In July, after the brood had started feeding, fifteen of these trees were given a second injection of the same material.

All but a few of these trees were known to be definitely infested by the Bronze Birch Borer. Examinations were made from time to time throughout the summer and fall. At one time small slits of bark were removed from trunks of a number of trees. Another time all the bark would be removed from one trunk for examination. These examinations showed consistently live, feeding, growing borers and badly channeled sapwood in the injected trees. In places borers were found feeding in the brownish streak, just above the injection hole, made by the ascending solution. In other places the borers had eaten entirely around the trunk of heavily injected trees. One tree 1½ inches in diameter was given six and one-third grams of aloin in May and another 2 grams in July. Nineteen days after the last injection 25 live borers were found feeding between the bark and sapwood on a space two feet long, which extended entirely around the trunk.

Those trees ranged from 1½ inches to nearly 2 feet in diameter. Comparatively large amounts of aloin were injected. In the larger trees as much as 200 grams were given at each of the injections. As aloin is intensely bitter this amount, if well distributed, should change the taste of wood in quite a large tree.

The aloes solution was prepared by agitating one part of powdered Curacao Aloes in ten parts of hot distilled water and then filtering out the undissolved residue.

Six trees, (previously given an aloin injection) were given an injection of aloes solution. The method followed closely that described by Dr. Pierson of Maine in his note on the cure of borers by aloes injection. Seven-sixteenth-inch holes, 2 inches deep, were made at intervals of 3 to 4 inches along the circumference and filled with the solution. The holes were sealed with a tightly driven cork whereas Pierson reported that he sealed the holes with paraffin.

The trees were examined at various times from a few days to two months after the injection. Except one large tree, from which only a small amount of bark was removed, numerous borers were found not far from the injection holes.

This is a brief resume of our second year of injection experimentation. The results, so far, are all negative. It should be possible to control both insects and disease by the injection of some material into the tree. Perhaps we have not located the correct material or the correct method but thru consistent and persistent work we hope in time to get the desired results.

Mr. W. S. Abbott: I should just like to say I am very glad to see the negative results brought forward in this line of work. So often the negative results are completely buried and the other entomologists never hear about them. If more of the entomologists would publish the negative results it would greatly assist the insecticide workers who are trying to enforce the insecticide law.

Mr. W. O. Hollister: That is the way we have felt, that people should know what has been done and know that so far as we are concerned it is not possible as yet to control either insects or disease by injection, but we are going to keep it up a year or two longer and see what results we get.

Mr. L. O. Howard: Do you know whether Professor Lipman of the University of California has followed out his work in that respect?

Mr. W. O. Hollister: We have had correspondence with him and we have changed our method from what he was using. I think he was using the tank method, the hose, what we used last year. This year, with the pressure we can control the amount much better, whereas before the tanks were high in the tree and hard to look after.

Mr. L. O. Howard: Do you know if he has continued his work?

Mr. W. O. Hollister: I don't know whether he is still working on it or not. I know we followed his work.

President R. W. Harned: The next paper is by W. C. O'Kane.

A POWER-DRIVEN GRASSHOPPER CATCHER

By W. C. O'Kane, *Durham, N. H.*

Abstract

A frame 14 feet long and 2 feet high, carrying a burlap bag of same length and height, and 4 feet deep, was suspended in front of a Ford chassis so that the lower edge of the frame touched the ground. Driven back and forth across fields the bag caught small grasshoppers by the bushel and stopped a serious infestation.

In the summer of 1927 there was a local outbreak of grasshoppers in a river valley in central New Hampshire. The species concerned were largely *Melanoplus femur-rubrum*, with some *M. bivittatus*. The outbreak was confined largely to one farm surrounded by hills.

I learned of it while hoppers were still quite small and found on inquiry that there had been real trouble the year before on the same farm. A standard grasshopper mash with amyl acetate was prescribed and was used on part of the farm, with reasonable success.

However, the owner, a young and energetic chap, wanted more visible results. He set about securing these in his own way.

His stock of machinery on the place included a Ford chassis, minus any superstructure except a small store-box. In the frame on each side near the front end he bored a quarter-inch hole. A bolt through each hole fastened a two-by-four on each side, the front of which stuck out in line with the frame about eight feet. The back end of each two-by-four continued for fifteen inches or so beyond the bolt hole and was thereupon engaged by a coil spring, both above and below. The springs were abstracted from an old Ford seat. Thus the two-by-four could move up and down on the bolt as a pivot and had a certain freedom of motion.

From the front end of the two-by-fours was suspended horizontally a long rectangular frame made of one-by-two-inch stock. This frame was about fourteen feet long and twenty-four inches wide. It was hinged to the two-by-fours in such fashion that it could swing back underneath them to an angle of 45° or could be swung around until it rested on top of them. The bottom of the frame was weighted with sheet lead so that it would just clear the ground.

To the edge of the frame was tacked a burlap bag as long and as wide as the fame itself and about four feet deep.

Thus equipped the inventor cranked up and started out, running his hopper catcher back and forth across his field. He told me that he could easily make thirty miles an hour. This may have been an exaggeration, but he certainly could cover a field pretty rapidly. The bottom of the frame swept the grass, touching the ground lightly as it went. When the inventor had collected a good lot of hoppers he turned the frame on top of the two-by-fours thereby taking a fold in the bag, drove to the barn, shook the hoppers down to one end of the bag and dumped them out in a ten-gallon can.

He said that in the course of four or five evenings, running his hopper catcher an hour or two each evening, he cleaned up the place. He buried twelve and a half bushels of small hoppers, which averaged about a quarter-inch long.

MR. L. O. HOWARD: Was it in the valley where they had most of the trouble?

MR. W. C. O'KANE: No.

MR. SAMUEL HOWARD: Have you a slide on that?

MR. W. C. O'KANE: No.

ADJOURNMENT: 4:05 o'clock.

PRECIPITATION AS A FACTOR IN THE EMERGENCE OF *EPILACHNA CORRUPTA* FROM HIBERNATION

By J. R. Douglass, *Bureau of Entomology, U. S. Department of Agriculture*

Abstract

Three years' study of the emergence of the Mexican bean beetle (*Epilachna corrupta* Muls.) from hibernation show that there is a definite relation between precipitation and the emergence of the beetle and that the percentage emerging is influenced directly by the temperature during the period of rainfall. It is also apparent that heat alone is not sufficient stimulus to produce emergence, as no beetles emerged on some of the hottest days during the season, and that the period of emergence is governed by a combination of the two factors. Emergence rarely occurs when the mean temperature is below 55°F., and reaches its maximum at a mean temperature of 58° to 69°F. Beetles in hibernation respond to the effect of artificial precipitation during the emerging season.

Method of Investigation

The emergence of the Mexican bean beetle from artificial and natural hibernation during the past three seasons has been studied, and some of the data obtained are given herewith. The experiments were carried on in Torrance County, New Mexico, at and 17 miles west of Estancia. The hibernation cages used during these investigations were constructed out of 2 x 4 inch lumber, and measured 4 feet wide, 6 feet long and 3½ to 4 feet high; they were covered with 14-mesh screen wire, and had removable tops. The tops were removed after the beetles had become dormant and were replaced before activity was manifested. In this manner conditions approximating, as nearly as possible, those prevailing under natural hibernation were obtained.

Cages Nos. 5, 6, 7 and 11 were located in the yellow-pine (*Pinus ponderosa*) region that covers the higher rolling hills along the foot of the Manzano Mountains. Cage No. 8 was located in the pinyon (*Pinus edulis*) formation that covers the intermediate forest region between the cedar (*Juniperus monsperma*) community, which clothes the lower rolling foothills that border the valley on the west, and the yellow-pine forest zone. Cage No. 10 was located in the short-grass or semi-desert formation of the Estancia Valley.

Cage No. 6, located at 7,000 feet elevation, has been in operation three years, oak leaves and pine needles having been used as the hibernation material. Cage No. 5, at an elevation of 7,050 feet, has been in use two seasons and the hibernation material has consisted of a combination of oak leaves and pine needles. Both cages are located on the south side of Tajique Canyon just below the first rim rock and are well protected. The following four cages have been in operation only one year: Cage No. 7, at an altitude of 6,975 feet, was located at the base of a steep hill or bluff, 30 feet from the canyon stream, with a northernly

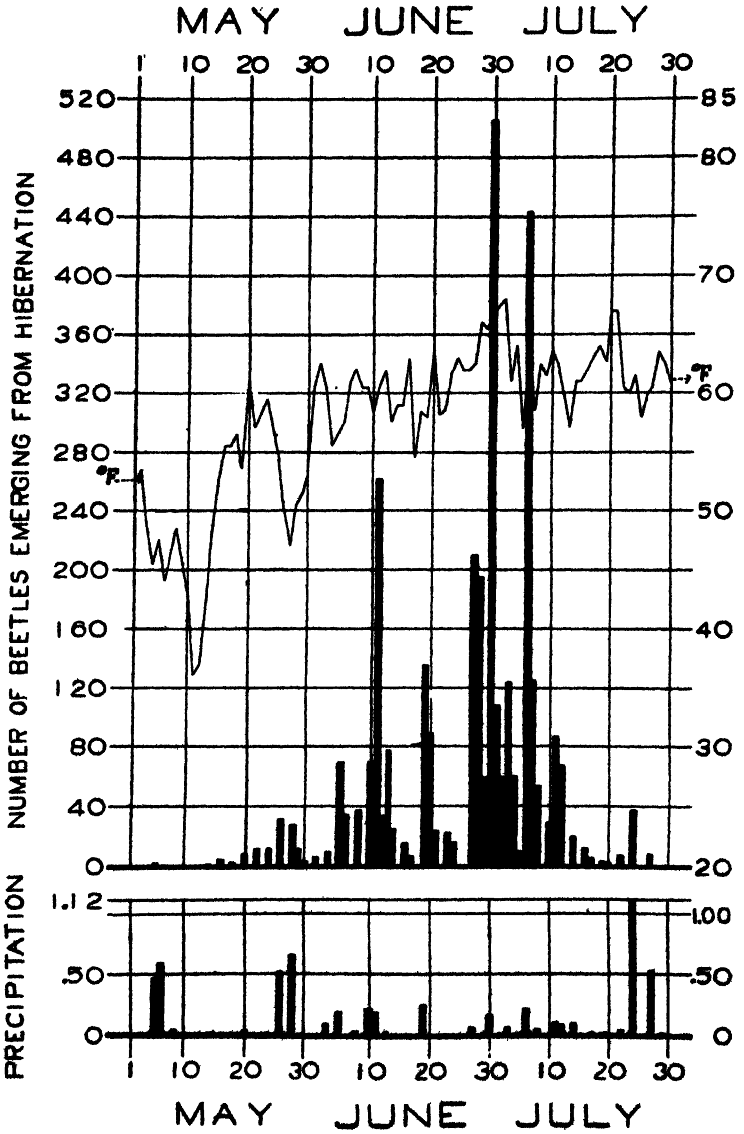

Fig. 16.—Mexican bean beetle: Graph Showing Emergence from Cages Nos. 5, 6 and 11, located in the yellow-pine forest zone, the beetle's natural hibernation quarters, during the emergence season of 1926.

exposure, where it would receive a large amount of moisture. The hibernation quarters consisted of pine needles and oak leaves. Cage No. 8 was located on the north side of a gentle rolling hill at an elevation of 6,800 feet in the juniper and nut-pine region, with pinyon needles as the hibernation material. Cage No. 10 was located out of the hibernation zone at an altitude of 6,100 feet, near the laboratory, in a suitable place where it would receive the maximum amount of snow without blowing; oak leaves, pine needles and bean vines were used as the hibernation material. Cage No. 11 was located at an elevation of 7,050 feet on the east side of a steep hill covered with large yellow pines, where the turf was heavy; pine needles were the hibernation material employed.

During the hibernation season of 1923-24, 5,540 beetles were placed in cage No. 6; in both 1924-25 and 1925-26 winters, 5,000 insects were used in this cage. In cage No. 5, 1,296 beetles were introduced during the fall of 1924 and 5,000 adults in 1925. During the fall of 1925, the following numbers of beetles were placed in the different cages: cage No. 7, 10,000; cage No. 8, 2,500; cage No. 10, 2,500; and cage No. 11, 1,500.

Beetles used during the hibernation season of 1923-24 were collected in irrigated gardens in the Estancia Valley. Adults for the season of 1924-25 were collected both in the foothill region of the Estancia Valley and in the Rio Grande River Valley, between Belen and Los Lunas, New Mexico. Insects hibernated in 1925-26 were collected in the irrigated area near Hoehne, Colorado, and in the Rio Grande River Valley, north of Albuquerque, New Mexico.

The temperatures given in Figure No. 16, and in Tables 1 to 3 inclusive, also for cages Nos. 5 and 6 in Table 5, are compiled from the meteorological records of cooperative observers. This station is located near Tajique, New Mexico, at an elevation of 7,100 feet, latitude 24° 48′, longitude 106° 18′, three miles northeast of the foothill experiments. The locations of the weather station and of the Tajique Canyon cages are very similar in regard to exposure, topography, drainage and environment. The precipitation data for the emergence seasons 1924 and 1925 were obtained from the same source. During the emergence season of 1926, rain gauges were established in close proximity to the different cages in order that more accurate data might be obtained. The meteorological data given in Table 4 and for cage No. 10 in Table 5 are those recorded by the writer at the laboratory 10 feet from the cage.

Observations of the foothill cages were made as often as time and conditions would allow, generally daily or at least every other day.

The cage located at the laboratory was observed daily. After emergence became general the active beetles were removed from the cages on days that an examination was made and the numbers thus removed were used in computing the percentages given in the tables.

EMERGENCE FROM ARTIFICIAL HIBERNATION

During the season of 1924 the first beetle emerged from cage No. 6 at 7,000 feet elevation on May 23 and emergence continued at irregular intervals until July 30. The emergence period for this season extended over a period of 68 days, as summarized in Table 1. The greatest number appeared over a rainy period of four days from July 1 to 4, inclusive, when 737 out of 1,304 beetles or 56.52 per cent emerged. It will be noted from a glance at Table 1, that 50.6°F. is the lowest average mean temperature at which emergence occurred and that this was during a period of precipitation. Table 1 shows that 176 and 123 beetles emerged during the periods ending June 9 and 23, respectively, without precipitation, but as the rain gauge was located three miles from the cage local showers could have occurred without being recorded.

TABLE 1. EMERGENCE FORM HIBERNATION IN CAGE NO. 6, AT 7,000 FEET ELEVATION DURING 1924

Weekly Period Ending	Average Mean Temperature For Period (°F.)	Precipitation (Inches)	Number of Beetles Emerging
May 26.........	56.8	0.00	3
June 2.........	50.5	.56*	35
9.........	61.5	.00	176
16.........	65.7	.20	62
23.........	65.5	.00	123
30.........	66.4	.42	91
July 7.........	60.4	1.31	737
14.........	63.8	.26	65
21.........	65.6	.75	21
28.........	60.2	2.91	1
Aug. 4.........	62.3	.29	1

*0.08 inch snow May 28.

The first beetle to emerge in 1925 was on April 12, in cage No. 6 at 7,000 feet elevation, but it reentered the hibernation material by April 14. The next beetle to emerge was on May 17 and emergence continued intermittently until August 1. The emergence period extended over a period of 76 days, with two distinct peaks of intense emergence, as shown in Table 2. The first peak centered on June 22 and the second on July 5. The heaviest emergence took place from July 2, to 6 inclusive,

TABLE 2. EMERGENCE FROM HIBERNATION IN CAGE NO. 5 AT 7,050 FEET ELEVATION AND CAGE NO. 6 AT 7,000 FEET ELEVATION DURING 1925

Weekly Period Ending		Average Mean Temperature For Period (°F.)	Precipitation (Inches)	Number of Beetles Emerging	
				Cage No. 5	Cage No. 6
May	19	54.7	.00	0	5
	26	59.0	T	0	1
June	2	56.7	.08	1	3
	9	57.9	.00	1	1
	16	62.5	.02	64*	1
	23	62.6	.43	14	57
	30	60.6	.03	4	1
July	7	63.3	.54	34	235
	14	65.9	.05	11	40
	21	70.2	.19	1	6
	28	63.5	1.66	0	11
Aug.	4	59.4	.86	0	7

*1¼ inches artificial precipitation June 10.

when during a period of five days 234 out of 363 beetles or 64.46 per cent emerged from cage No. 6. In cage No. 5 at 7,050 feet elevation the greatest number of beetles emerged June 10, when within a period of five hours, during an experiment in which water approximating 1¼ inches of precipitation was sprayed into the cage, 64 beetles or 49.23 per cent emerged. Under natural conditions 51.51 per cent of the re-

TABLE 3. EMERGENCE FROM HIBERNATION IN CAGE NO. 5 AT 7,050 FEET ELEVATION, CAGE NO. 6 AT 7,000 FEET, CAGE NO. 7 AT 6,975 FEET, CAGE NO. 8 AT 6,800 FEET AND CAGE NO. 11 AT 7,050 FEET DURING 1926

Weekly Period Ending		Average Mean Temperature For Period (°F.)	Precipitation (Inches)	Number of Beetles Emerging				
				Cage No. 5	Cage No. 6	Cage No. 7	Cage No. 8	Cage No. 11
May	5	48.8	.48	0	1	2	0	1
	12	42.8	.64	0	0	0	0	0
	19	52.0	.01	1	5	0	0	0
	26	56.8	.55	12	41	3	0	8
June	2	55.1	.71	17	30	10	0	0
	9	59.1	.29	80	57	17	0	12
	16	59.9	.41	205	186	7	1	86
	23	59.9	.25	95	150	3	8	32
	30	63.9	.22	391	548	7	19	46
July	7	62.3	.26	254	597	37	27	77
	14	60.4	.30	47	166	14	11	43
	21	63.7	T	1	17	13	0	4
	28	60.6	1.70	9	14	64	1	30
Aug.	4	63.6	.06	0	0	6	0	0

maining beetles emerged during a period of three days from July 4 to 6, inclusive. Table 2 shows similar emergence in the two cages and that the peaks of emergence and of precipitation occur together. The effect of precipitation as the stimulus influencing emergence is best illustrated by the data for the weekly period ending June 16. The greatest emergence in cage No. 5 was during the artificial precipitation, when 64 insects issued, as compared to one adult emerged in cage No. 6 during the period.

The first emergence in the foothills during the season of 1926 was on April 8, when five adults were found on the screen in cage No. 7. These beetles later reentered the hibernation material. Permanent emergence occurred on May 2 and continued irregularly until July 30. This emergence period extended over 89 days and was very general and intensive for several weeks in the yellow-pine forest zone. The greatest number emerged from cage No. 6 at 7,000 feet elevation from June 27 to July 8, inclusive, when during a period of 12 days 1,171 out of 1,812 beetles or 64.62 per cent emerged. During the same period 645 beetles out of 1,112 or 58 per cent emerged in cage No. 5 at 7,050 feet elevation. From cage No. 7 the heaviest emergence took place from July 22 to 27, inclusive, when 64 beetles emerged or 34.97 per cent in a period of six days. In cage No. 8 the peak of emergence occurred in a period of five days from July 3 to 7, inclusive, when 27 beetles or 38.57 per cent emerged. The greatest emergence from cage No. 11 occurred on June 11 when 69 beetles or 20.35 per cent emerged. Table 3 shows that the periods and peaks of emergence from cage hibernation in the same canyon within two miles varies under varying circumstances, depending

TABLE 4. EMERGENCE FROM HIBERNATION IN CAGE NO. 10 AT 6,100 FEET ELEVATION DURING 1926

Weekly Period Ending	Average Mean Temperature For Period (°F.)	Precipitation (Inches)	Number of Beetles Emerging
May 5.......	52.2	0.74	15
12.......	49.8	.01	0
19.......	55.4	.02	104
26.......	62.8	.38	37
June 2.......	58.4	.58*	49
9.......	63.8	.22	40
16	66.2	.39**	40
23.......	65.8	.02	33
30.......	69.1	T	41
July 7.......	67.8	1.04	182
14.......	64.6	.06	7

*Hail. **0.30 inch hail.

upon local conditions, but under natural conditions it is doubtful if beetles in search of hibernation quarters would attempt to hibernate in locations approximating conditions found in cages 7 and 8.

Active beetles appeared in cage No. 10 at 6,100 feet elevation on April 9, when 15 beetles were noted crawling over the hibernation material during a rain and sleet storm, but later in the day they re-entered the material. This appearing and disappearing continued with every period of precipitation until May 5; after that time no beetles emerged until the 15th, when two beetles appeared very active, as the temperature on top of the hibernation material was 104°F. May 16, 99 beetles or 18.16 per cent emerged within two hours during a slight sprinkle of rain with an average temperature of 74°F. for the period. From July 4 to 6, inclusive, 154 beetles or 28.26 per cent emerged in a period of three days in which 0.72 inch of rain fell. The last beetle emerged in this cage on July 14, as shown in Table 4.

Figure 15 shows the daily emergence from hibernation during 1926 in cages Nos. 5, 6 and 11, which were located in the yellow-pine forest zone. The location of these cages represents a typical cross section of the natural hibernation quarters. The emergence from these cages is summarized in Table 3. It will be noted that the rates of emergence from these three cages are very similar and that in general they respond together to the stimulus effecting emergence. The effect of the combination factors, temperature and precipitation, is best illustrated by the data given in Figure 15, which show a definite relation between rainfall and emergence and that the intensity of emergence is governed by the temperature. The indications are that rainfall starts the emergence and the prevailing temperature during the period of precipitation or just following it is the accelerator. Figure 15 shows that three beetles emerged when the mean temperature was below 50°F., and that 79 beetles issued at temperatures between 50° and 55°F. No major emergence occurred on days in which the mean temperature was below 57°F. The greatest number of beetles emerged on days when precipitation occurred and decreased as the hibernation material dried out. At 50.5°F., it required 0.66 inch of precipitation to influence 28 beetles to emerge. Then at 60.5°F., 0.18 inch of rain brought out 263 beetles. Again, 66.5°F. and 0.16 inch of rainfall stimulated 505 beetles to issue.

FROM NATURAL HIBERNATION

Data upon emergence of the beetles from natural hibernation were obtained by recording the increase of beetles in fields located in canyons nearest the mountains, the natural hibernation quarters. In 1922 a few beetles were taken in irrigated gardens on June 13 by J. E. Graf,[1] who states that "apparently the heaviest emergence took place from June 19th to June 24th." From a study of the daily precipitation recorded in the hibernation area for the month of June, one finds that 5 of the 6 days given above were rainy, and that 0.91 inch of precipitation fell during that time. Preceding this period was a dry spell with a considerable excess of temperature for 16 days.

During the season of 1924 the first beetles appeared in the fields on June 20, six days after 0.20 inch of rain, the first precipitation during June, and increased until June 23. From June 24 to 30 there was little increase in infestation. General rains fell in the mountains from June 28 to July 4, inclusive, when a precipitation of 1.73 inches was recorded for the period and was followed by a gradual increase in the number of beetles entering the fields from July 1 to 11, inclusive. In one small bean field the number of overwintered beetles increased from 2 on June 20 to 15 on June 23 and 33 on June 28, and from 98 on July 3 to 557 on July 9. In another field the insects increased from 2 on June 21 to 4 on July 2, and from 290 on July 5 to 2,556 on July 11.

The first beetles appeared in 1925 on June 18 in a field of volunteer beans located in Canyon De Los Migos at an elevation of 7,100 feet, near the foot of the mountains. On June 17, 0.29 inch of rain fell over the area drained by this canyon. Four light showers fell from June 1 to 15, totalling 0.05 inch of precipitation. There was a great increase in infestation from June 18 to 21, when the first peak of infestation occurred. This peak was followed by a gradual decrease in beetles entering the field from hibernation and a gradual increase in adults leaving the field. There was little change in infestation from June 21 to 28, when as many as 30 beetles were noted on the larger plants. A general migration from the field was observed June 28, July 2 and 3, when beetles were noted on weeds, cedar, oak and pine trees in the canyon below the bean field. Very few beetles entered the field from hibernation during the period from June 28 to July 4. General rains fell in the canyons from July 3 to 5, inclusive, and were followed by a rapid increase in the number of beetles that entered the field from July 5 to 7, inclusive, when the second peak of infestation occurred. By July 8 the majority of the leaves on the volunteer (early) bean plants were destroyed and the beetles left the field and continued their migration down the canyon. From July 8 to 13 few beetles entered the field, since infestation was very light on the 13th.

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[1] Unpublished data by J. E. Graf, Bureau of Entomology.

In 1926 the first beetles were found on June 17 in fields located in canyons near the foot of the mountains. There was little or no change in the infestation until June 28 and 29, when there was a slight increase in infestation, followed by a lull until July 2, when again the number of overwintered beetles increased until July 6. The next increase was noted from July 10 to 12, inclusive, when the first large increase of the season occurred. This was followed by a four-day period when no noticeable change in infestation could be observed, as beetles migrate in and out of the fields during the entire spring migration period. The last migration period of the season was from July 17 to 22, inclusive, when a 49 per cent increase in overwintered beetles was noted over that of July 12.

These results show that emergence from natural hibernation is slower than from cage hibernation, but this is readily understood when it is known that beetles become semi-active during periods when factors are favorable for emergence in the early spring, and Howard[2] has shown that the majority of beetles move about their hibernation quarters on warm days. The great range in temperature in the Southwest would tend to cause the beetles to become active in the day and reenter their hibernation material late in the afternoon; as it is not uncommon to have a daily range of over 40°F. during the spring. Beetles emerging from natural hibernation enter the field before being recorded, which process requires some time, depending upon distance and other factors influencing flight.

FACTORS INFLUENCING EMERGENCE

Temperature is a factor in the emergence of the bean beetle from hibernation, as it has been observed that emergence in the spring begins during the first warm days the latter part of May, especially if there has been rainfall. An examination of Figure 16 and Tables 1 to 4 will show that emergence rarely occurs when the mean temperature is below 55°F. and attains its maximum at a mean temperature of 58° to 69°F. Two major emergences occurred on days with a mean temperature of 56.5° and 57.5°F., as shown in Table 5, but the precipitation fell and the insects emerged during the heat of the day. No major emergence occurs from the effect of temperature alone; as it will be noted from Table 5, that no emergence occurred from cage No. 10 on June 12, 23 and July 2, when the mean temperature was 70.5°, 71° and 73°F., respectively; though a few beetles may emerge on warm days without the aid of rainfall, especially if the hibernation material is damp.

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[2] Howard, Neale F., and English, L. L., 1924. Studies of the Mexican bean beetle in the Southeast. U. S. Dept. Agri. Bul. 1243, p. 50.

The effect of precipitation on emergence is best illustrated by the data presented in Table 5, which show by comparison that rainfall is the greatest of the two stimuli influencing the emergence of the Mexican bean beetle from hibernation, especially after the mean temperature has increased to 50°F. Emergence occurs at much lower temperature during periods of precipitation, but in such cases the beetles resume hibernation after the precipitation ceases. Local showers during the heat of the day will bring out of hibernation more beetles than the same amount of precipitation under lower temperatures. Local rainfall over one canyon area will have no effect on the insects about to emerge in the adjacent canyons. It will be noted from Tables 1 and 2 that whenever heavy rains are preceded by hot, dry weather, the majority of the beetles emerge in a period of a very few days; as during the emergence seasons of 1924 and 1925. In 1926 little precipitation was recorded every week during the emergence season, as shown in Tables 3

TABLE 5. EMERGENCE FROM HIBERNATION ON SOME OF THE HOTTEST AND WETTEST DAYS

Year	Cage	Date	Temperature (°F.) Max.	Min.	Mean	Precipitation (Inches)	Number of Beetles Emerging	Per cent Emerging
1924	6	June 17	86	48	67	0.00	3	0.23
		24	85	50	67.5	.00	8	.61
		July 1	76	44	60	1.10	428	32.82
		2	67	50	58.5	.18	199	15.26
1925	6	June 14	79	55	67	.00	0	.00
		27	79	52	65.5	.00	1	.27
	5	June 10	73	44	56.5	1.25*	64	49.23
	6	July 5	74	50	62	.31	92	25.34
		6	78	48	63	.06	42	11.57
1926	6	June 24	79	47	63	.00	9	.49
		29	84	47	65.5	.00	26	1.43
		July 2	84	52	68	.00	36	1.99
		June 27	79	46	62.5	.06	133	7.34
		30	83	50	66.5	.16	297	16.39
		July 6	74	47	60.5	.21	283	15.62
	10	June 12	84	57	70.5	.00	0	.00
		23	87	55	71	.00	0	.00
		29	93	49	71	.00	1	.18
		July 2	93	53	73	.00	0	.00
		May 16	78	37	57.5	.02	99	18.16
		July 5	84	55	69.5	.32	91	16.70

*Artificial precipitation.

and 4, with the result that emergence was general and intensive over a period of 6 weeks in the foothills and 8 weeks at the laboratory.

The effect of precipitation in the form of hail on emergence is best illustrated by the data for cage No. 10 at 6,100 feet elevation. On May 27, 0.58 inch of rain and hail fell and decreased the mean temperature from 64° to 50.5°F. without influencing the emergence of a single beetle. Again on June 9, 0.30 inch of rain and hail fell and decreased the temperature from 83° to 54°F. within three hours without stimulating emergence. Figure 16 and Tables 1 to 5 show that there is a definite relation between the precipitation and emergence of the Mexican bean beetle from hibernation and that the percentage emerging is directly influenced by the temperature during the period of rainfall. Similar results have been obtained at Birmingham, Alabama, and in Ohio.[3]

DIFFERENTIAL EFFECTS OF CONSTANT HUMIDITIES ON *PROTOPARCE QUINQUEMACULATUS* HAWORTH, AND ITS PARASITE, *WINTHEMIA QUADRIPUSTULATA* FABRICUS

By HAROLD M. HEFLEY, *Zoological Laboratory, University of Wisconsin*[1]

ABSTRACT

Tomato moth larvae, both parasitized and unparasitized by the Tachinid, *W. quadripustulata* were subjected to different constant humidity percentages at constant temperature during the pupal period of both host and parasite. The effects of the moisture on the length of the pupal period and the viability were noted.

It was found that as the humidity increased the viability of the host decreased, while that of the parasite increased. Both host and parasite showed a maximum rate of metamorphosis near 73.4% humidity at 27 degrees Centigrade.

INTRODUCTION

Most workers investigating the problem of the effect of external conditions on the rate of insect matamorphosis have dealt mainly with temperature, and attributed most of the changes in rate to this factor. In most cases the experiments reported have been conducted with very accurately controlled temperatures, but without similar control of the humidity. To be convincing the experiments should be repeated with carefully controlled humidity as well as temperature. Sanderson, (1910), was one of the first to recognize that humidity is a factor that should be taken into consideration by the economic worker dealing with the ecological aspects of insect control. So far as the writer is aware, Glenn (1922), in his work on the development of the codling moth is the only student of this problem who has definitely considered humidity and evaporation as negligible factors in the rate of insect metamorphosis. Cook (1925), in noting the effect of weather conditions on the development of the pale western cutworm found that after a dry summer, a large crop of cutworms appeared the following year. The same investigator in a later paper, (1926), found that the rainfall influenced the insect by directly affecting the animal, by exposing it to the attacks of its parasites, by forcing it out of the soil, and by favoring the development of its bacterial and fungous diseases. Bacterial and fungous diseases seem to be the main factors concerned. Cutworm larvae reared in the laboratory under very favorable conditions have a mortality of well over 50% and as even a temporary excess of moisture in a breeding cage induces an epidemic of disease, it is safe to assume that the same diseases would be of equal importance in the field.

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[3] Data from correspondence with Neale F. Howard, Bureau of Entomology.

[1] Contribution from the Zoological Laboratory, University of Oklahoma.

Headlee (1913), showed that a moist atmosphere hastened the development of *Mayetiola destructor*, while dry air greatly retarded it. Dry air also retarded the development of *Lygellus epilachnae*,(Giard, 1896) but accelerated the development of the pupae of *Pieris brassicae*, (Ürech 1890). Headlee in a later work, summing up the work of previous investigators drew the following conclusion: "That the effect of atmospheric humidity (water vapor) upon the speed of insect metabolism is seemingly extremely variable."

This conclusion while seemingly almost hopeless, yet may be easily explained by the fact that every species of insect has a different concentration of water in the body fluids. Consequently, a given percentage of atmospheric humidity might approach the optimum conditions for one insect while it would be decidedly unfavorable for another species.

Bachmetjew (1907) considered that there was for each insect a concentration of body fluids most favorable for the maximum speed of metabolism. If the concentration of the body fluids is low, i. e., the body water content high, exposure to dry air will remove the surplus water, and metabolism speeds up. If the concentration of the body fluids is at the optimum, exposure to moist air prevents the loss of water and the metabolic rate is held at the maximum. Continued exposure to dry air however reduces the body water content too much, while continued exposure to moist air is injurious because of the ensuing digestive disorders:—bacterial and fungous diseases.

In a previous investigation (1925), the writer showed that moisture played an important role in the development of the pupal stages of the tomato moth, and its tachinid parasite. In that investigation the temperature was not controlled, so it was deemed expedient to conduct a series of experiments with the temperature kept as nearly constant as possible to ascertain the reactions of both host and parasite to different constant percentages of humidity. These form the basis for the following discussion.

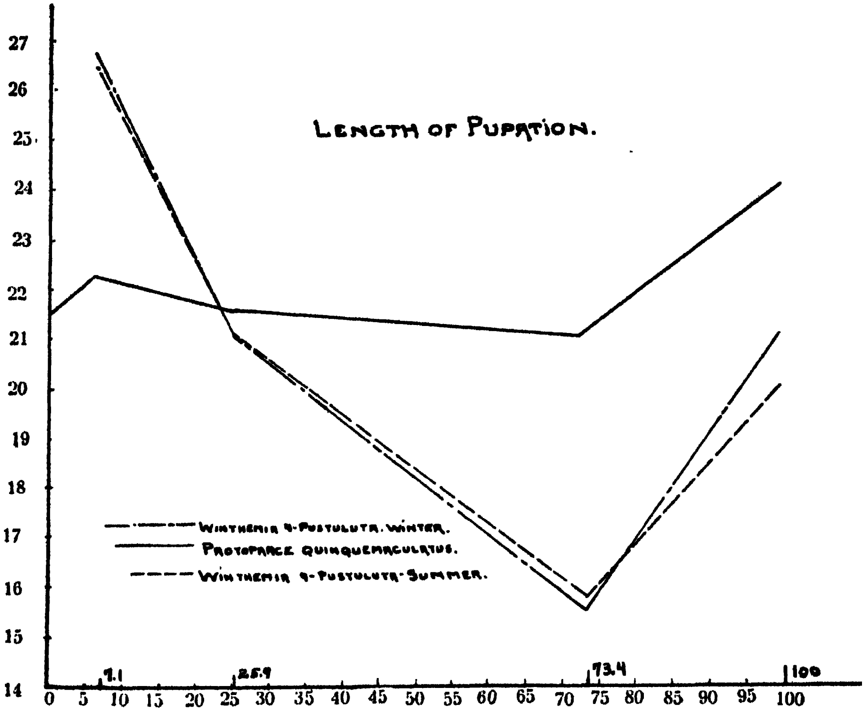

Fig. 17. Humidity percentage.

Experiments

A constant humidity apparatus similar to that used by Headlee (1914) was set up. The reaction chambers were kept at a nearly constant temperature of 25–30 degrees C. The air current was obtained by the use of a large aspirator pump connected to the water supply, and kept running during the course of the experiments. Saturated salt solutions of known vapor tensions were employed as a means of controlling the various humidities. The air current was drawn through a reaction chamber consisting of a quart mason fruit jar with two pieces of ¼ inch glass tubing sealed into the lid, containing the control animals.

It was then led respectively through a flask of concentrated sulphuric acid, through reaction chamber No. 1, (0% humidity), through a saturated solution of Lithium carbonate, through reaction chamber No. 2 (7.1% humidity), through a saturated solution of Calcium chloride, through reaction chamber No. 3, (25.9% humidity), through a saturated solution of Sodium chloride, through reaction chamber No. 4, (73.5% humidity), through distilled water, through reaction chamber No. 5 (100% humidity), and finally through a water trap, to safeguard the experiments from any backflow from the water pump.

As soon as the animals showed signs of being ready to pupate, they were placed in the reaction chambers one third full of soil and allowed to pupate. At first it was thought that the animals might not be subjected to the influence of the moisture laden air beneath two or three inches of soil, but as pupae both covered and exposed reacted identically at a given humidity, during the concluding experiments the pupae were not molested.

VIABILITY

At a humidity of 0%, a 100% emergence of the unparasitized host took place but the mortality of the parasites was 100%. The presence of even one parasite in a host will ultimately cause its death. The pupae of the parasite are unable to stand the evaporating powers of dry air, while the host pupae are able to live in a dry atmosphere, and are in addition free from the attacks of fungous and bacterial diseases. At a humidity of 7.1%, 80% of the unparasitized hosts emerged, but only 33.4% of the parasites developed. At 25.9% humidity, 66.66% of the hosts reached maturity while 47.7% of the parasites developed. At 73.4% humidity the emergence of the host dropped to 44.44% while that of the parasite reached 100%. At 100% humidity 42.66% of the hosts emerged while the parasites maintained an emergence of 100%. The reason for this phenomenon is found in the interaction of the parasite and moulds upon the host, and the direct effect of humidity on the parasite.

The number of parasitized larvae is a constant factor for a given season (varying as the rainfall of the previous season), so the viability of the host may be measured in terms of the frequency of development of its parasitic moulds at a given humidity, plus the factor of parasitism by the tachinid fly.

The mortality of the parasite however, is due directly to humidity, as it is not affected by the moulds which destroy the host. Tachinid pupae are easily desiccated, which accounts for their high mortality at low humidities. For both summer and winter broods, the viability of the parasites may be said to be directly proportional to the amount of atmospheric humidity up to about 73.4%, above which the viability remains at 100%, up to and including a humidity of 100%.

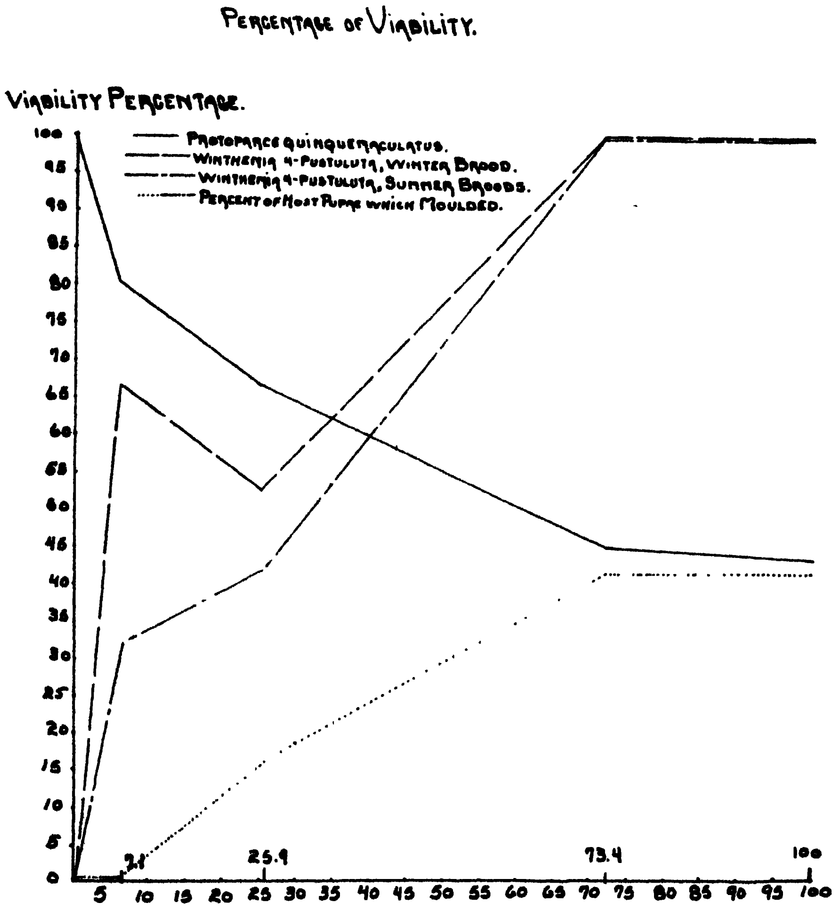

Fig. 18. Humidity percentage.

There was not enough material at hand to be able to determine the viability of the wintering host pupae, though a random guess would place it considerably lower than the summer broods. This needs to be either confirmed or disproven by further investigations. While the emergence of the tomato moths was 100% at a humidity of 0%, the number that actually reached maturity was quite different. Out of the cases studied, 74% of the moths emerging in an atmosphere devoid of moisture failed to expand enough to be able to fly. In the other humidities normal wing expansion occurred. The flies also matured normally in all humidities in which they emerged.

LENGTH OF THE PUPAL PERIOD

The length of the pupal period was also affected, though not to such a marked degree as the viability. At 0% the average length of the pupal period of the summer brood of the host was 21.5 days, at 7.1% 22.25 days, at 25.9% 21.5 days, at 73.4%, 21 days, and at 100% humidity, 24 days. The data at hand are too meagre for a statement to be made concerning the effect of different humidities on the winter brood.

A humidity of 0% caused a complete mortality in the pupae of *Winthemia quadripustulata*, consequently no definite length of pupal period can be assigned to this humidity. At 7.1% the pupal period was 26.33 days, at 25.9% humidity, 21 days, at 73.4% humidity 15.75 days, and at 100% humidity, 20 days.

In some insects there seems to be a period of hibernation necessary each year, in order that the species may survive and be perpetuated. Other species hibernate only when adverse conditions such as unfavorable humidity and temperature make it impossible for metabolism to be carried on in the usual manner, (DeOng, 1922, Roubaud, 1922). Individuals of the latter class when subjected to favorable conditions, take no longer to mature the brood that would normally have pupated than one of the summer broods. Individuals of the first class however, are speeded up in their metabolic activities with difficulty, and even then the length of the summer brood is never approximated by the winter brood, even when subjected to the most favorable environmental conditions.

The tomato moth belongs to that class of insects which requires a period of hibernation, while the tachina fly does not. If a normally pupating brood of *Winthemia* be subjected to favorable conditions of humidity and temperature it will develop in the same time as the summer broods.

The data are meagre concerning the winter brood of the hawkmoth, as only two individuals were brought to the adult stage. One emerged after 120 days at 73.4% humidity and 27 degrees C. and the other after 132 days at 0% humidity and 27 degrees C. *Winthemia quadripustulata* on the other hand, showed a variance in the length of the pupal period in the summer and winter broods of only one day at a humidity of 100%, at 27 degrees C., and such a small variation at the other humidities as to be negligible.

DISCUSSION

In reviewing the foregoing experiments the writer finds it hard to submit to the assertion that humidity should merit a place in the index of negligible factors assigned to it by some investigators, since he found it to have a very definite effect at a given temperature.

The optimum for *Winthemia qnadripustulata* is near a humidity of 73.4% at 27 degrees C. since it had the shortest pupal period at that per cent. *Protoparce quinquemaculatus* however, is much more resistant to desiccation than its parasite, as the imagoes showed a 100% emergence at 0% humidity while all of the parasites were killed. A humidity of 100% retarded the development of both host and parasite since it was above the optimum, as the pupal period was increased 4.25 days in the case of the parasite, and 4 days in the host. *Protoparce quinquemaculatus* does not have a definite optimum as does *Winthemia quadripustulata* since it showed a variance of only 1.5 days in the length of the pupal period between 0% and 73.4% humidity, while the parasite showed a variance of 10.5 days between 7.1% and 73.4% humidity.

The viability percentages however throw a somewhat different light on the behavior of the animals at the various humidities. At a humidity of 0% all of the parasites failed to develop, while all of the hosts emerged. In this case the hawkmoth has a greater resistance to desiccation than its parasite, which was destroyed. This phenomenon cannot be attributed to a variance in the metabolic optimum of the two insects, but merely to a differential resistance of host and parasite to desiccation, since both showed the highest rate of development at the same humidity, 73,4%.

As the humidity increased from 0% to 100%, the viability of *Protoparce quinquemaculatus* dropped from 100% to 42.44%, and was only 44.44% at 73.4%, humidity,—its optimum with reference to its metabolic activity. The parasite increased steadily in viability from 7.1% to 73.4% humidity, from 33.4% to 100% due to the reduction in desiccation as the humidity increased. Above 73.4% humidity it showed a 100% emergence, though the rate of development was markedly slowed by the lowering of the evaporating power of the air.

CONCLUSIONS

1. Atmospheric humidity has a definite effect on the rate of metabolism in the pupae of *Protoparce quinquemaculatus* and *Winthemia quadripustulata.*

2. The length of pupation of *Protoparce quinquemaculatus* is nearly constant from 0% to 73.4% humidity at 27 degrees C. The length of the pupal period of *Winthemia quadripustulata* is greatest at a humidity of 7.1% and decreases up to 73.4% humidity. As the humidity increases to 100% the length of the pupal period in both host and parasite increases also.

3. *Protoparce quinquemaculatus* because of its resistance to desiccation at low humidities does not have a definite optimum, but maintains a nearly constant rate of development up to 73.4% humidity at 27 degrees C., decreasing in rate as the humidity goes above 73.4%.

4. The viability of *Protoparce quinquemaculatus* is greatest at 0% humidity at 27 degrees C. The mortality at higher humidities is due to the attacks of fungous and bacterial diseases, none developing below a humidity of 7.1% at 27 degrees C.

5. The viability of *Winthemia quadripustulata* is greatest at a humidity ranging from 73.4% to 100% at 27 degrees C. due largely to the low resistance of the puparia to desiccation at low humidities, and their freedom from disease at high humidities.

6. The optimum rate of development of *Winthemia quadripustulata* is near a humidity of 73.4% at 27 degrees C. since the length of pupation decreases as the humidity increases up to that percentage, and increases as the humidity goes above 73.4%

7. There is an hibernation period in one of the broods of *Protoparce quinquemaculatus*; this brood survives the winter, but no definite period of hibernation was demonstrated for *Winthemia quadripustulata*, since a temperature of 27 degrees C. caused metamorphosis in the same time as noted for the summer broods. In *Protoparce quinquemaculatus* the shortest length of pupation of the winter brood at 27 degrees C. was 120 days or nearly five times the length of the normal summer brood period.

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The codling moth parasite, *Ascogaster carpocapsae*, seems to be increasing in the vicinity of Yakima. During 1927 a block of 58 unsprayed trees about a mile northwest of the point of original introduction of this parasite were kept banded and examined weekly. From these bands 24,800 codling moth worms have been taken during the season, of which 7,700 or 31 per cent, were parasitized. Last year a parasitism of 22 per cent was found. Of these approximately 1,300 have been shipped to British Columbia for introduction there, and about 1,300 more have been distributed to various places in Washington. The rest are being held until spring, when they will be sent to various apple-growing districts in the Pacific Northwest.

E. J. NEWCOMER, *Yakima, Wash.*

SOME PRELIMINARY NOTES ON THE USE OF SODIUM ARSENITE DUST AND SPRAY IN THE CONTROL OF THE MORMON CRICKET (*ANABRUS SIMPLEX* HALDE.) AND THE LESSER MIGRATORY GRASSHOPPER (*MELANOPLUS ATLANIS* RILEY)[1]

By R. L. Shotwell, *Assistant Entomologist*, and F. T. Cowan, *Junior Entomologist*, *Bureau of Entomology, United States Department of Agriculture*

Abstract

This paper covers some preliminary work on the use of sodium arsenite, both as a dust and as a spray, in the control of the Lesser Migratory Grasshopper and the Mormon Cricket in Montana. Experiments were made to determine the effectiveness of this material as a barrier against migrating swarms of these insects. Excellent results were obtained, and they justify further work on the use of this material in grasshopper and mormon cricket control.

Introduction

Sodium arsenite in the form of dusts and sprays has been used successfully in the control of grasshoppers in South Africa for a number of years. Malley (1), Grano sky (2) reports this poison to be successful against locusts in Russia. In the United States, Washburn (3) of Minnesota made some tests during the summer of 1911 using a spray containing 3½ lb. commercial sodium arsenite, 1½ gal. molasses and 180 gal. water. This solution was sprayed on the vegetation and very good results were obtained. For the most part investigators in mormon cricket and grasshopper control in this country have confined their efforts to the various poisoned bait formulae. However, the reports of the above-mentioned men indicate that sodium arsenite dusts and sprays may be of value in the control of these pests in other regions. Owing to the type of most of the country inhabitated by mormon crickets in Montana, there are serious objections to the use of poisoned bran mash. Many of the cultivated farms of Montana, and especially those in the dry-farming sections, are surrounded by large tracts of waste or abandoned land. This land offers ideal breeding grounds for both the mormon cricket and the lesser migratory grasshopper, from which they migrate into the cultivated fields.

During a serious outbreak the farmer using bran bait must expend considerable time, labor, and material in order to protect his crop, since this method of control involves repeated application of the bran mash. This is illustrated by the fact that farmers in Hill County, Montana, have reported poisoning the same area as many as eleven times in order to stop one migration of grasshoppers from this waste land. Another instance in western Montana during the summer of 1926, one farmer poisoned on the average of three times a week for two months to save 40 acres of wheat from incoming crickets. Therefore, situated as these farms are, it would be better to use some poison that would constitute a barrier against these migrating hordes, which does not involve such a large expenditure of time, labor, and material as does the use of bran mash, and would at the same time prove effective.

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[1] *Anabrus simplex* Halde., Decticinae, Tettigoniidae, Orthoptera.
Melanoplus atlanis Riley, Locustinae, Locustidae, Orthoptera.

Malley has demonstrated the efficiency of sodium arsenite dust and spray against the migrating swarms of locusts in Africa. Both the mormon cricket and the lesser migratory grasshopper congregate in swarms when migrating or when seeking shelter, thus offering somewhat similar conditions for the use of this material in their control. With all of these points in mind, the experiments hereinafter described were carried out in order to determine the efficiency of sodium arsenite dusts and sprays to fill the need for better control measures.

Liquid sodium arsenite, containing eight pounds of arsenic to the gallon, was mixed with water in various proportions to form the spray. The solution was then applied directly on the swarm by means of a knapsack sprayer. Chemically pure sodium arsenite dust was applied by means of a knapsack duster, and when possible allowed to drift with the wind over the swarm. Except in the cases of caged specimens, the percentages of kill were estimated.

THE USE OF SODIUM ARSENITE DUST AND SPRAY IN MORMON CRICKET CONTROL

The following experiments with sodium arsenite were carried on by the junior author in the Flathead Indian Reservation in western Montana during the summer of 1926. This reservation was thrown open to settlement in 1910, and a great deal of it was homesteaded by white settlers. However, a portion of it still remains in Indian allotments and is used mostly for pasture. This Indian land for the most part is seriously over-grazed, and offers ideal breeding grounds for the mormon cricket. Very little control work has been done and consequently the crickets have developed into a real menace to crops.

The eggs of such of the mormon crickets as are located in agricultural sections are normally laid during the early summer, in vacant land, and for the most part in barren soil, such as ditch banks, roadsides, and waste lands. The young crickets hatch during March and April, but do not leave the hatching grounds for any great distance until they have reached the fourth instar, or about a month after hatching. During this time they are confined to relatively small areas, feeding a little on such vegetation as is immediately available. As soon as it becomes cool in the evening, or during cool cloudy weather, the young crickets congregate for mutual warmth around the base of rocks, sagebrush, or anything that offers shelter. At this stage they are very easily killed by a contact poison, good results having been obtained under similar conditions with kerosene emulsion by Melander (4) in Washington. When the crickets are thus congregated, it is necessary to cover only a proportionately small area in order to treat an entire band.

After they start to migrate, the crickets scatter out over a larger area, but still continue to collect in compact groups at night. This offers further opportunity for treating a large group with comparatively little outlay of work and materials.

During their early instars, the nymphs feed but little, and therefore seem to be very hard to kill with a poison bait. Eight tons (dry weight) of poisoned bran mash was scattered in the Charlo district in Lake County, Montana, during the latter part of April, yet very poor results were obtained. This was discouraging to the farmers of that community, and they immediately gave up the struggle as impossible. Similar results were obtained in nearly every other section of the reservation where early poisoning was done. It was necessary, therefore, to find some method of control that would give immediate and appreciable results.

Taking all the foregoing points as a basis of procedure, the following experiments with sodium arsenite dusts and sprays were carried out in the control of mormon crickets.

Sodium Arsenite Spray

On May 1, a series of sprays were tried out against migrating crickets in the third and fourth instars. The crickets were congregated along a ditch which lay directly across the direction of their migration. Sprays in the following proportions were used: 1 to 128, or one ounce liquid sodium arsenite to one gallon of water; 1 to 64; 1 to 32, and 1 to 16. Examination of the results was made twenty-four hours later, and it was found that the 1 to 128 and 1 to 64 sprays gave only slight kills, while the 1 to 32 and 1 to 16 gave 60 per cent to 70 per cent for the former, and 70 per cent to 90 per cent for the latter. The authors believe that weaker solutions may give good results when used against crickets in the first and second instars, and further work on this proposition will be done.

With these results in mind, solutions of 1 to 32 and 1 to 16 were applied as sprays in several different localities and under various conditions. The results were practically the same as previously mentioned in every instance. When applied to crickets congregated in alfalfa severe burning resulted, especially from the 1 to 16 spray, from which the sprayed plants never recovered. However, the success of the spray depends upon application in the spring before the crickets leave the hatching grounds, since the eggs are not laid in cultivated fields. Spray applied to the crickets on their hatching grounds causes practically no damage to foliage from burning because the soil is for the most part bare, and such vegetation as there is has little if any commercial value.

Sodium Arsenite Powder

Sodium arsenite powder was not obtained until after the crickets had become adult. No experiments, therefore, were carried on with the dust against the nymphs. However, excellent kills were obtained in every instance where the powder was applied by dusting, up to and including twenty feet from the point of application. A chemically pure product was used. It may be possible that good results can be obtained with a commercial grade, or by mixing with a cheap carrier, Granovsky having reported good results from the use of hydrated lime as a diluent. It may be possible also that effective kills can be obtained at much greater distances from the point of application among nymphs than among adults. However, further work is necessary in order to find whether or not these assumptions are correct.

Some burning occurred where the dust was applied directly to alfalfa. However, the plants were not seriously injured, and the second crop was not affected.

The Lesser Migratory Grasshopper (*M. atlanis* Riley)

The experiments with the lesser migratory grasshopper were carried on by the senior author in Hill County, in north central Montana, during the summer of 1926. In this locality occupied farms are few and scattered, and there is much abandoned land. What farming is done, is for the most part small-grain farming on a large scale. Entire sections of a large proportion of this abandoned land are alternately sown to wheat one year by neighboring farmers, and left to stubble the next. These stubble fields offer ideal breeding grounds for this species of grasshopper. Previous to a serious outbreak, the egg pods are to be found in great numbers around the roots of the stubble. The young hoppers hatch out in May and June, and, as a rule, migrate into the neighboring cultivated fields at some time during the nymphal stage. When a serious outbreak occurs, it is a difficult and costly proposition for the farmers to protect their crops by means of the poisoned bran mash, from the ravages of the hordes of grasshoppers migrating from these neighboring stubble fields. In such instances, the problem is to effect a good kill over a large area in as short a time as possible.

Along the fence-rows bordering both stubble and cultivated fields may be found dense patches of the Russian thistle, in which the grasshoppers congregate in great numbers during a migration or when seeking shelter. This swarming habit offers a good opportunity for quick, effective kills when a contact poison is used. Where the bran mash is used, the amount of kill depends solely upon whether or not the grasshoppers eat the mash. An effective contact poison overcomes this element of chance. It was with all these points in mind that the following experiments were carried on in the control of the lesser migratory grasshopper.

The experiments with the sodium arsenite spray and dust as barriers were carried out against migrating fourth and fifth instar nymphs. These grasshoppers were moving from a 160-acre stubble field into a wheat-field across the road. Practically the whole of this migration was taking place across a strip of road about 300 yards long, lying between these two fields. For convenience this strip was divided into two parts, one part being used for a spray and the other for a dust barrier.

SODIUM ARSENITE SPRAY

In the experiments with the sodium arsenite spray, the liquid sodium arsenite was used in various proportions. The cages used in this work were constructed of wire screen and were 2 by 2 by 2 feet in size. The experiments with the spray may be classed under three heads: grasshoppers caged and sprayed with solutions of various strengths; the spray used as a barrier or on an infested area; and a determination of the effectiveness of the spray upon grasshoppers not previously sprayed but moving into vegetation which had been treated.

In the first experiment specimens were collected and placed in five cages about one hundred and fifty to a cage. Four of such cages were then sprayed with solutions varying from one ounce of the sodium arsenite to a gallon of water to four ounces to a gallon inclusive, while the other cage was left as a check and not sprayed. Counts of the number of dead in each cage were made for two consecutive days and the dead removed each day. A more rapid kill was obtained with the stronger solutions, though the percentages of total kill were approximately the same in all the cages sprayed. The total kills secured for the four solutions varied from 98 per cent to 100 per cent, whereas the check cage showed only a 3 per cent mortality. These results show that as weak a solution as 1 to 128 is effective.

In the second experiment there was a moderate growth of Russian thistles in the area across which the migration from the 160-acre stubble field was taking place, and the nymphs were congregating in these weeds in great numbers before filtering into the wheat. Half of this area was sprayed twice. The first application was made with a 1 to 32 solution at the rate of ten gallons to the acre. The second application was made three days later over the same area, and a 1 to 42 solution at the rate of twenty-two gallons to the acre was used. Enormous kills were obtained both times, and the two applications completely stopped that portion of the migration, wiping out practically all of the grasshoppers. In each case within three hours after the area had been sprayed, marked effects were shown by the great numbers of dead and dying.

Under this experiment a one acre plot was also laid out where the grasshoppers, mostly fifth instar nymphs, were congregated for shelter in a dense growth of Russian thistles. This whole area was sprayed with a 1 to 64 solution at the rate of sixteen gallons to the acre. At the end of the third day all the remaining nymphs in this area were dead. A check plot not sprayed showed the same number of live grasshoppers as at first.

The object of the third experiment was to obtain information regarding the effect of the treatment on grasshoppers moving into the sprayed areas. A small patch of Russian thistles was sprayed with a 1 to 64 solution and two cages were then placed over these sprayed thistles. A check cage placed over non-sprayed plants was used. Specimens, mostly adults, were taken from other parts of the field not sprayed, and placed in all of these cages. Counts of the dead were made each day for three consecutive days. The two cages over the sprayed plants showed 94 per cent and 100 per cent kills respectively at the end of the three-day period, while the check cage showed only a 6 per cent mortality. These results indicate that large kills are obtained among grasshoppers moving into sprayed areas within a few hours after the application of the spray. In other words, a spray barrier is effective not only against the individuals already within the barrier but also against those that move into it.

In all these experiments some burning was observed in the Russian thistles, but since all this work was carried on in thistle patches, this was a desirable result. However, burning would be a serious obstacle to the use of the spray in cultivated crops.

SODIUM ARSENITE DUSTS

In the experiments with the dust the powdered, chemically pure, sodium arsenite was used and was applied by means of an ordinary hand duster. In all cases the dust was allowed to drift with the wind over the area involved. In case of caged insects the wire screen cages were used. The experiments may be classed under three heads: (1) the dust used on caged insects at various distances from the point of application; (2) the dust used as a barrier against migrating swarms or to destroy an infestation; and (3) an experiment to determine the effectiveness of the dust against grasshoppers not previously dusted but coming into vegetation already dusted.

The first experiment is divided into two parts carried on at different times. In the first part specimens, mostly fifth instar nymphs, were placed in five cages which were located at 10, 20, 40, 60, and 80 feet respectively from the point of application. The dust was allowed to drift over these cages from these various distances and counts were made of the dead for two consecutive days. One hundred per cent kills were obtained at the first three distances; at 60 feet 99 per cent, and at 80 feet 95 per cent kills were obtained. A check cage was used and showed only a 3 per cent mortality. Another part of this experiment was carried out several weeks later in which adult grasshoppers were used. Five cages of grasshoppers were placed at 100, 125, 150, 175, and 200 feet respectively from the point of application. The dust was allowed to drift over these cages as before. A check cage was used and counts of the dead were made over a three-day period. The kills observed varied from about 80 per cent in the cage at 200 feet to 100 per cent in the cage 100 feet distant. The results in both of these experiments show that good kills are obtained at relatively long distances from the points of application. They also indicate a general rule that the greater the distance from the point of application, the slower the rate and the lower the total percentage of kill. However, it must be taken into consideration that the dust-clouds in these experiments were created by means of a small duster and were not of any great size. No doubt good kills at greater distances could be obtained by the use of a larger duster, capable of expelling greater amounts of the powder, since more particles would drift to the outer limits of kill of the smaller duster.

The second experiment was divided into two parts. A strip 100 feet in width and 560 feet in length along the road across the direction of the migration, was dusted at the rate of six pounds to the acre. This area represented a part of the territory previously mentioned and across which the migration was taking place. Fourth and fifth instar nymphs were congregated in great numbers in the moderate growth of Russian thistles found in this area. The dust was applied at 3.00 p. m. Within an hour after the application of the dust, these young grasshoppers began to show marked effects of the poison and by ten o'clock the next morning thousands were found dead around the base of the thistle plants. In some places the number of dead per square foot ran from one hundred to one hundred and fifty. Three days later the migration was still going on and the nymphs had again congregated in great numbers in this area and had also entered about 200 feet into the wheat along a strip about 600 feet in length. This whole area, representing approximately three acres, was dusted at the rate of about 2½ pounds to the acre. The next day as many as one hundred and sixty dead were counted around the base of a single plant. The infestation was completely wiped out and the migration stopped. Little or no burning occurred in the wheat.

The third experiment was carried out in order to obtain information concerning the effectiveness of dust barriers against migrating grasshoppers moving into the barriers. During the migration new groups of grasshoppers kept working into the barriers continually. A small patch of Russian thistles was dusted and two cages were placed over the dusted plants. A check cage placed over non-dusted plants was used. Specimens, mostly adults, not previously dusted, were taken from other parts of the field and placed in the three cages. Counts of the dead were made for three consecutive days. The total kills for the three-day period in the two cages over the dusted plants were 91 per cent and 95 per cent respectively, whereas the total mortality in the check cage was only 7 per cent. These results indicate that grasshoppers entering the dusted area within a reasonable length of time after application were destroyed in practically as high percentages as those in the dusted area at the time of application. This is a big factor in favor of the use of the dust as a barrier.

The experiments with the dust indicate that it kills over relatively long distances from the point of application, and is effective as a barrier in that it destroys practically all of the grasshoppers in the barrier, and also those moving into the dusted area for some time thereafter.

SUMMARY

The authors believe that these experiments, though preliminary in nature, show great possibilities for the use of sodium arsenite dust and spray in the control of grasshoppers and mormon crickets, and warrant a more extensive study of the subject. Further work will consist of more detailed investigations in order to determine the efficiency of this method of control. Such work will include the use of carriers, methods of application, and cost per acre.

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CORN BORER CONTROL AND THE TEN MILLION DOLLAR CLEAN-UP CAMPAIGN

By L. H. WORTHLEY

ABSTRACT

The European corn borer, *Pyrausta nubilalis* Hubn., was discovered near Boston, Mass., in 1917 and in the Lake Erie region in 1919. In 1922, an area of 5,836 square miles was known to be infested in the Lake region. In 1926 this had increased to 68,380 square miles. Intensity of infestation had increased to alarming numbers in 1926.

The International Corn Borer Committee was appointed in 1926. Ten million dollars ($10,000,000) were appropriated by the 69th Congress to carry out the 1927 spring clean-up campaign. Direction of the work centered in the Bureau of Entomology field headquarters at Toledo, Ohio.

The "clean-up" area comprised 2,500,000 acres of corn land. The funds were available March 14, and actual field work started March 21. The work was placed largely in the hands of the United States Department of Agriculture by the States.

Government equipment was used on 170,000 acres, of which 68,000 acres were treated under compulsory regulations; 202,338 farms were visited on which there were 2,505,005 acres of corn; 185,000 farms satisfactorily passed inspection and received the extra labor fee; 4,000 field and road units were used in the work and over an area of 35,000 square miles as many as 7,000 men were employed at one time.

The European corn borer was discovered in this country near Boston, Mass., in 1917, and near Schenectady, N. Y., and in the Lake Erie section in 1919. In 1922 there were 5,836 square miles of infested area in the Great Lakes Region. In 1926 this had increased to

68,380 square miles and the infested area in the United States totalled 93,786 square miles. At that time the intensity of infestation had increased in the Lake Region to an extent that caused considerable alarm on the part of those interested in the control of the insect.

In September, 1926, a conference of the International Corn Borer Organization was held in Detroit, Mich., which was attended by representatives from the Corn Belt and many other sections. In connection with this conference an inspection trip was made through a part of the infested area of Ohio and Michigan and to Essex and Kent Counties in Ontario, Canada. This conference resulted in the appointment of a committee to decide what action would seem most advisable in connection with the control of the European corn borer in the United States. This committee was largely guided in its proceedings by its knowledge of devastations of the corn borer in Canada and Europe.

This organized movement and the public consciousness of the seriousness of the corn-borer problem in relation to the Corn Belt induced the second session of the 69th Congress to appropriate ten million dollars ($10,000,000) to enable the Secretary of Agriculture to "apply such methods of eradication or control as in his judgment" might "be necessary." This fund was used to carry out what is now commonly called the "1927 SPRING CLEAN-UP CAMPAIGN." The purpose of that campaign was to determine whether, by concerted effort under unified control and with uniform procedure, the spread of the insect into new territory could be retarded and the borer population held at such a minimum as would prevent it from inflicting commercial damage to the corn crop in territory already infested.

The campaign was organized along three major lines of activity, namely, an educational program, publicity work, and control operations. The last was carried on by the Bureau of Entomology and the Federal Horticultural Board under additional authority conferred by State legislation. The writer was in charge of field operations with general headquarters at Toledo, Ohio, and branch headquarters at Erie, Pa.; Cleveland, Ohio; Howell, Mich.; and Auburn, Ind.

In the act providing for the control of the European corn borer Congress stipulated that the various participating States, namely: New York, Pennsylvania, Ohio, Michigan, and Indiana, should provide the necessary regulatory legislation. The Department interpreted this to mean legislation requiring the farmers in the "clean-up" area to destroy all cornstalks and corn débris in fields, feed lots, barnyards, etc., on or before May 1. It was also arranged that the States deputize the employees of the United States Department of Agriculture, thereby authorizing them to enter private property and, in case this was not properly cleaned within the specified time, to do such work as was necessary, the cost of this to be charged in whole or in part to the property owners.

Provision was made by Congress to compensate the farmers for the extra work involved, and the Secretary of Agriculture issued regulations allowing a maximum of $2 per acre for extra labor when the farmer cleaned his premises in a satisfactory manner. The Federal appropriation of $10,000,000 became available February 23, 1927, but none of it could be expended until all of the States involved had provided legislation and funds for cooperative work. This condition was not fulfilled until March 14, when the expenditure of this special fund began. The purchase of a large quantity of field equipment for this work was one of the first things to be given consideration. The details preliminary to the award of the contracts were completed in the interval that elapsed between the time the appropriation was made and the date upon which it was certified that the States had provided the necessary legislation, so that on March 14 many awards were made for equipment, and on March 18 the first equipment was received at Toledo, Ohio. Work was started in the field on March 21.

It was then necessary to complete an organization to supervise the control work. This consistéd principally of appointing a supervisor for each county together with six inspectors to assist him.

Regulations governing the clean-up were issued by the several States involved, and the direction of the work was placed largely in the hands of the United States Department of Agriculture.

The area to be cleaned up consisted of the entire infested areas of Ohio, Michigan, and Indiana, eight counties in western Pennsylvania, and three counties in western New York. There were estimated to be 2,500,000 acres of corn land in this area. The program prepared for this campaign was based on the assumption that the farmers would do all the work on 2,000,000 acres or 80 per cent, leaving the Government to do the work on 500,000 acres, or 20 per cent, of the entire area. Equipment sufficient for this purpose was accordingly provided, and the writer believes that had the season been a normal one, and it had been necessary, this acreage could have been cleaned up.

Carload shipments of equipment were received as follows:

Toledo, Ohio,	252 carloads
Elyria, Ohio,	68 "

Ashtabula, Ohio,	3	carloads
Auburn, Ind.,	24	"
Howell, Mich.,	24	"
Meadville, Pa.,	26	"
Silver Creek, N. Y.,	21	"

making a total of 418 carloads. On all of these shipments a total of only $4 demurrage was paid.

For purposes of supervision the control work was divided into five branches, namely:

(1) Field Operation
(2) Engineering and Maintenance
(3) Advisory and Research
(4) Accounting, Finance and Disbursements
(5) Supplies, Purchases and Property

The first field operation was that involved in the proposal to lend stubble pulverizers and tractors to farmers prior to May 1 to be used largely in fields already planted to small grains in which corn stubble of the previous summer existed. This equipment, consisting of a tractor and pulverizer for each unit, was operated by Federal forces and for this a charge of $1 per acre was made, such charge to be deducted from any extra labor fee that might subsequently become due the farmer.

All farmers in the infested territory were visited at least once before May 1 and advised as to what would be expected of them in the way of cleaning up their fields. Also a copy of the regulations issued by the Secretary of Agriculture, setting forth the requirements to be fulfilled to receive extra labor fee, was mailed to every farmer in the "clean-up" area.

Owing to the continued wet weather during the entire period of the campaign, the time limit for the completion of the farmers' work was extended from May 1 to May 15. This continued wet weather necessitated, in some cases, exemption, in the area where less than 1 per cent infestation occurred, from the regulations requiring the cleaning up of stalks and stubble in fields where small grains were growing. On May 16 compulsory work was started. Wherever it was apparent that the farmer was trying earnestly to do his work and had been handicapped largely by weather conditions, a further extension of time was allowed. Approximately 170,000 acres of corn land were worked on with Government equipment, 68,000 acres of which were treated under the compulsory regulations.

The approved methods used in the campaign were:

Stubble Pulverizing,
Plowing Cleanly,
Poling, Raking, and Burning,
Machine Burning, and
Hand Picking of Stalks and Débris.

In early June, the final inspection was started and it then became necessary to appoint additional inspectors to determine the fee for extra labor due the farmers.

We were in touch with 202,338 farms on which there were 2,505,005 acres of corn, and in relation to which 1,154,200 reports were submitted. In all some 185,000 farms satisfactorily passed inspection. A total of 4,000 field and road units were used, and the maximum number of employees engaged at any one time was 7,000, who were working over an area of 35,000 square miles.

All Bureaus of the United States Department of Agriculture, the State forces, and the farmers gave the most wonderful cooperation that was ever experienced in any large control problem.

ENDOWMENT FUND NEWS

The following members have been added to the list of State chairmen for raising the endowment fund since the list was prepared for the December number of the JOURNAL.

Illinois—W. P. Flint, Urbana.
Kansas—George A. Dean, Manhattan.
Maine—H. B. Pierson, Dept. of Forestry, Augusta.
Maryland—E. N. Cory, College Park.
Minnesota—A. G. Ruggles, St. Paul.
Missouri—L. Haseman, Columbia.
New Mexico—J. R. Douglas, Box 353, Estancia.
Pennsylvania—T. L. Guyton, Bureau Plant Industry, Harrisburg.
Vermont—H. L. Bailey, Bradford.
Washington—R. L. Webster, Pullman.
Ontario—L. S. McLaine, Ottawa.

The total amount in the permanent fund of the Association at the close of the year 1927 was $5,339.05, an increase of $1,316.50 during the year. This resulted from accrued interest, transfer of money from the general fund and the payment of two life membership fees.

No direct outside contributions to the fund were made during the year.

With a more complete organization it is anticipated that a much greater gain will result during the present year.

Attention is again called to the advantage of becoming a life member of the Association. There are at present 5 life members and with a total membership of over 900 in the Association, the number of life members should be materially increased. The plan which has been adopted of spreading the payment for life membership over a period of years places it within the reach of more members than ever before.

It is assumed that most of the members will read this article in the JOURNAL. How many will respond?

A. F. BURGESS,
Chairman, Endowment Committee

Scientific Notes

Spiders as Greenhouse Pests: A complaint was recently received from a florist in Rochester, N. Y., stating that a great number of small black spiders were weaving webs on the roses in his greenhouse to such an extent as to become objectionable. The spider proved to be *Erigone atra* Blackwall, widely distributed in Europe and the eastern United States.

C. R. CROSBY

Bibliography of Liquid Baits. The writer is preparing a bibliography of references to liquid baits used to attract or to control various insects. Special emphasis has been placed on baits attractive to the Lepidoptera as the Oriental Fruit Moth. A study of such baits, however, merges with a consideration of poison baits used for ants as well as the poison sprays now generally used for fruit flies. The bibliography has been completed for the years 1918 to 1928.

S. W. FROST, *Arendtsville, Pa.*

An Insecticide Symposium will be held during the April meeting of the American Chemical Society in St. Louis, Missouri. A number of papers of interest to economic entomologists will be presented, and all those interested are invited to attend. Invitation is also extended to entomologists who are not members of the Society to present papers. It is expected to have a number of papers on such subjects as arsenical residue on fruits and vegetables; new contact insecticides and new fumigants.

Those intending to present papers should communicate with R. C. Roark of the Insecticide Division, Bureau of Chemistry and Soils, Washington, D. C.

An Observation on Mating Habits of ***Leptinotarsa undecimlineata.*** *Leptinotarsa undecimlineata* is similar in form and size to the Colorado potato beetle, *L. decimlineata.* It is of a pale yellowish color, with eleven black stripes. In the West Indies and other Caribbean countries it is commonly found feeding on *Solanum torvum*, a spiny shrub which is not cultivated, but whose fruits are used in cooking in some places. The sexes are normally about equal in size, except when the female becomes greatly distended with eggs. The following observations were made in Pinar del Río Province, Cuba, during one afternoon in 1925, on four pairs of beetles.

When the eggs are mature, a male climbs to the dorsum of the female, where he crawls about for a short time. He then comes to rest with his head over her thorax, in the usual mating position. Copulation lasts about one minute, after which the male climbs cephalad on the female, while she selects a place on the leaf, and deposits ten or twelve eggs. She then moves a short distance, the male resumes the mating position, and copulation is repeated. The female deposits about ten more eggs in contact with the first group, to form a single mass. While the female is ovipositing, the male sometims climbs about her dorsum; at other times he rests in one place, usually over the thorax. As soon as she stops ovipositing, however, he moves caudad, and copulation again takes place at once. The process is repeated many times during the day.

CHARLES H. BALLOU

Moth Borer Damage to Different Varieties of Sugar Cane. In an interesting little article under this title in the October issue of the JOURNAL OF ECONOMIC ENTOMOLOGY, Messrs. Holloway and Haley give us an explanation of the fact that, after the P. O. J. Canes replaced the striped and purple in the Argentine Republic, damage by the moth borer ceased to be a problem, as follows:

"The new varieties have given a number of stubble crops in Argentina as against one or two stubble crops of the old varieties. This means that less and less cane is planted, and more and more springs up each year from the stubble. Now it has been found that a dangerous source of borer infestation is in the planted stalks, the borer larvae developing in the stalks into issuing adults making their way through the slight covering of soil ready to oviposit on plants of the grass family. Thus, the less cane there was planted, the fewer borers were planted in the stalks, and as more and more of the long stubbling varieties were planted, the hibernating larvae were progressively reduced."

This theory, while an ingenious one, and superficially sound, must be abandoned as it is based on the absolutely erroneous hypothesis that the old canes in the Argentine produced only one or two stubble crops. As a matter of fact, in the old days in the Argentine, with the old striped and purple varieties, eight and ten stubble crops were not particularly uncommon, and the average up to the time of their replacement by the P. O. J. varieties was between four and five stubble crops. While it is true that the P. O. J. canes give promise of producing several more stubble crops than the old native cane, inasmuch as sixth, seventh and eighth year stubble was largely handled in the last crop, just the opposite conditions to those assumed by Holloway and Haley prevailed during the period that reduced borer damage was particularly noticeable in the Argentine. That is to say that during the years 1917 to 1920, the entire cane area of the Province of Tucuman was being laid down to the new varieties, and in these years, which coincided with a subsidence of moth borer injury, larger proportions of plant cane were probably harvested than in anv similar period before or since in the history of Tucuman cane culture.

Furthermore, we have to face the fact that, due to the surplus of sugar during the past few years, there has been little cane planted in Tucuman since about 1924. Nevertheless, despite the fact that the last two crops have been almost entirely of stubble cane, borer damage has again been on the increase during the past two years.

ARTHUR H. ROSENFELD

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

FEBRUARY, 1928

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

Separates or reprints, if ordered, when the manuscript is forwarded, will be supplied to authors at the rates given below. Note that the number of pages in a reprint may be affected somewhat by the make-up, and that part of a page is charged as a full page. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

One hundred separates or reprints at $1.50 per page or plate. Additional hundreds or less, 4 pages or less, $1.00; 5-8 pages, $1.50; 9-12 pages, $1.75; 13-16 pages, $2.00, 17-24 pages, $3.00; 25-32 pages $4.00. Covers suitably printed on first page only, 100 copies, or less, $4.50; additional hundreds, or less, $1.75. Plates inserted, $1.75 per hundred or less. Folio reprints, the uncut folded pages (50 only), sixteen page signature, or less, $3.00. A discount of 10 per cent and 20 per cent from the above prices will be allowed on orders of 500 and 1000 reprints respectively.

The presidential address calls attention in a masterly way to the great strides in entomology taken by the South. Many of us realized that good work was being done though few possessed a comprehensive idea of the scope of the work. There is probably no section in the United States which offers greater opportunities for economic entomology— vital problems of health as well as those relating to the control of crop pests. At the Philadelphia meeting we listened to a masterly summary of entomological work on the Pacific Slope. It occurs to the Editor that there should be a similar exposition of the accomplishments of the eastern or northeastern entomologists, especially as we have a Northeastern Branch. Fortunately science does not recognize political or regional divisions except when defining quarantine lines—frequently a necessity. The catholicism of economic entomologists was most admirably exemplified when the entomologists' dinner was quietly manipulated into a most gratifying tribute to the Dean of our calling, one deservedly loved by all—Dr. L. O. Howard. The Southern entomologists worked this up and all of us are indebted to them for making possible such a delightful tribute. President Harned had good reason to be proud of his associates and the section they represent.

Attention is called to the fact that the Editor's address will change about March 10. Keep it in mind when writing.

Also note reduction in prices of Indices I–III to the Literature of American Economic Entomology, announced on page IV.

Obituary

WILLIAM LOCHHEAD

Professor William Lockhead, for many years a member of this Society, died at his home, at Macdonald College, Que., Canada on March 26th.

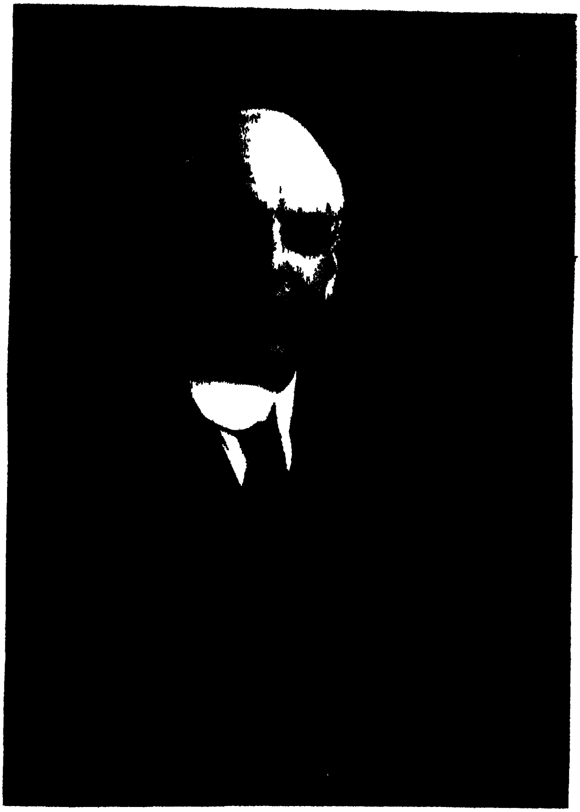
William Lochhead was born on April 3rd, 1864, at Listowel, Ontario. He studied at McGill University, receiving the B.A. degree in 1885. For some years he held the position of Science Master in the Collegiate Institutes of Galt, Perth and London, Ontario. In 1895 he obtained the degree of Master of Science at Cornell University. In 1898 he was appointed Professor of Biology at the Ontario Agricultural College.

In 1906, when in Macdonald College, the faculty of Agriculture of McGill University, was still in the course of construction, he was called to the Chair of Biology. In 1920 the Department of Biology was divided, and Professor Lochhead was made Professor of Entomology and Zoology.

Owing to an affection of the heart, Professor Lochhead was obliged to retire in 1925, and in recognition of his services to McGill University, he was made Emeritus Professor of Entomology and Zoology.

During his tenure of the Chair of Biology at the Ontario Agricultural College, Professor Lochhead held also the position of Provincial Entomologist, and was instrumental, during this period, in instructing the growers in modern methods of insect control. He was a fellow of the American Association for the Advancement of Science and of the Canadian Society of Technical Agriculturists, Past President and Director of the Ontario Entomological Society and the Quebec Pomological Society, President of the Quebec Society for the Protection of Plants, and member of several learned societies in Canada and the United States. He has published several bulletins and papers dealing with agricultural pests, is the author of a text book on Economic Entomology, and was for several years editor of the "Journal of Agriculture."

His distinction as a teacher and his kindly, genial and sympathetic manner endeared him alike to colleagues and students, who, on his retirement, in token of their affection, commissioned Mr. Horne Russell, P. R. C. A., to paint his portrait, which now hangs in the library of the College.



W. Lochhead

Current Notes

The annual public address of the Entomological Society of America was delivered Tuesday evening, December 27, by Dr. H. T. Fernald.

A new entomological building is being constructed at the Iowa College and Station for the study of insects important in Iowa.

Mr. S. H. Short, general foreman in charge of gipsy moth field work in Quebec, has returned to Ottawa headquarters for the winter.

Dr. H. G. Dyar went to New York on October 22, and while there examined some types of Limacodidae in the American Museum of Natural History.

Miss Mabel Colcord, librarian of the Bureau of Entomology, Washington, D. C., was a recent visitor to the new Japanese Beetle Laboratory at Moorestown, N. J.

See Association advertisement on page IV for reduction in price of Indices I to III to the Literature of American Economic Entomology.

Dr. W. H. Larrimer, of the Bureau of Entomology, left Washington on November 29 for a brief visit to the New Orleans laboratory on business concerning the recent dusting work.

Dr. Henry T. Fernald has been appointed director of the Graduate School at the Massachusetts Agricultural College, and Dr. C. E. Gordon has been appointed head of the division of science.

According to *Experiment Station Record,* Professor Henry A. Ballou has been appointed by the British government to the newly established office of Commissioner of Agriculture for the British West Indies.

At the Colorado Station an addition costing approximately $700 has been made to the entomology building, to be used as a parasite laboratory in connection with codling moth control work.

On September 12, Mr. R. T. Webber returned from a trip to Europe and northern Africa, having spent seven months abroad in collecting and sending parasites of the gipsy moth to Melrose Highlands.

According to *Science,* John A. Comstock has been appointed acting director of the Los Angeles Museum and will serve in that capacity during the absence in Europe of William Alanson Bryan.

Dr. W. Dwight Pierce is investigating sugar cane insects for a plantation company in the Philippine Islands. His address is care of Victorias Milling Company, Victorias, Occ. Negros, P. I.

Mr. C. C. Hill, in charge of the Carlisle, Pa., field station of the Bureau of Entomology, began on November 28, a survey trip relating to the Hessian fly work through Delaware and the eastern shore of Maryland.

Dr. F. E. Lutz of the American Museum of Natural History, New York City, visited the U. S. National Museum on November 10 and 11, and studied some of the Centrine bees of the West Indies in the Museum collection.

Mr. George I. Reeves, in charge of the Salt Lake City field laboratory of the Bureau of Entomology, visited Reno, Nevada, Sacramento, Calif., and Parma and Burley, Idaho, in the latter part of November, to examine alfalfa meal mills.

Mr. L. L. Reed, who has been engaged in European corn borer and gipsy moth scouting work, left Ottawa on December 9 for St. John, N. B., where he will assist in the inspection of nursery stock during the winter months.

Mr. O. I. Snapp, in charge of peach insect investigations of the Bureau of Entomology at Fort Valley, Georgia, gave the principal address at the annual meeting of the South Carolina Peach Growers' Association at Columbia, S. C., on November 16.

According to *Science*, Dr. R. J. Tillyard, entomologist and chief of the biological department of the Cawthron Institute of Scientific Research, Nelson, New Zealand, has been appointed to take charge of entomological investigations under the Australian Council of Scientific Research.

Mr. Troy Thompson, who for nearly six years has been engaged in the work of controlling the sweet potato weevil in southern Mississippi, resigned from the Bureau of Entomology on October 31 to become connected with the Alabama State Department of Agriculture.

Recent visitors to the Division of Insects, U. S. National Museum, were Alan S. Nicolay, Upper Montclair, N. J.; Dr. George Salt, Bussey Institution; Professor J. S. Hine, Ohio State University; J. C. Crawford, North Carolina State Department of Agriculture; R. C. Williams, Academy of Natural Sciences, Philadelphia; and Ernest Bell, Flushing, N. Y.

According to *Science*, a station at which useful insect parasites are kept and bred for the benefit of agriculture has been established by the Empire Marketing Board in London. Parasites are shipped all over the Empire wherever they are needed to destroy noxious insects or plants.

Mr. H. L. Seamans left Lethbridge, Alta., for Ottawa on November 7, spending two days en route at St. Paul, Minn., in consultation with Professor R. N Chapman. Mr. Seamans arrived in Ottawa on November 15, returning to Lethbridge on November 29, shortly after the close of the Branch conference.

Mr. Cornelius B. Philip, of the Division of Entomology of the University of Minnesota, has been appointed Entomologist to the Yellow Fever Commission which the International Health Board has established in West Africa. He will sail via London early in March and will be located either in Nigeria or the Gold Coast.

Mr. Philip was for two years assistant to Dr. Riley in the course in Medical Entomology and for the past year has been connected with the Experiment Station of the University of Montana. He had returned to the University of Minnesota for the purpose of completing his thesis for the doctorate.

Gipsy moth scouting in Quebec terminated for the season on November 30, and it is gratifying to note that no further signs of the pest have been discovered. Since similar negative results were obtained in 1926, it appears most probable that the Henrysburg outbreak has been completely eradicated.

Dr. William Schaus, of the U. S. National Museum, visited New York City October 27–30, and returned with a fine lot of moths presented to the Museum by Mr. Frank Johnson. Dr. Schaus visited Pittsburgh November 13–15, to examine material in the Lepidoptera collections in the Carnegie Museum.

Messrs. K. W. Babcock and A. M. Vance, who have for some time been connected with the investigations of the corn borer in Europe, have returned to headquarters at Arlington, Mass., to review the past four seasons' work and to confer with Bureau officials as to the status of the project.

The meetings of the Pacific Slope Branch of the American Association of Economic Entomologists will be held at Pomona College, Claremont, Calif., June 13–16, 1928, in connection with the joint meeting of the Pacific Division and the Southwestern Division of the American Association for the Advancement of Science.

Dr. Ahmed S. Hassan of Facous, Egypt, who has been studying for several years with Professor E. O. Essig at the University of California, called at the Division of Insects, U. S. National Museum on November 8. He was especially interested in the methods of preparation and installation of the collection.

According to *Science*, Dr. T. U. H. Ellinger returned in November from Europe where he has organized the international corn borer investigations instituted under the auspices of the International Livestock Exposition, Chicago. Corn borer research is now under way at ten institutions in the countries of France, Germany, Hungary, Jugoslavia, Roumania, Sweden, and Denmark.

Mr. L. B. Smith attended the meetings of the Ontario Entomological Society at Ottawa, November 17 and 18, and presented a paper entitled "The Japanese Beetle and Methods of Control." While there he had an opportunity to look over the very fine collections of Diptera and Coleoptera belonging to the Entomological Branch, Canadian Department of Agriculture.

The fifth annual conference of entomologists of Indiana met at the University of Notre Dame, Notre Dame (South Bend) the day before the State Academy meetings, December 1. The following attended and participated in the conference: C. F. Adams, H. F. Dietz, A. C. Kinsey, S. R. Esten, W. P. Morgan, Ralph Voris, E. B. Williamson, H. I. Spieth, F. E. Scheaffer, L. W. Turner, and J. J. Davis.

Mrs. Doris H. Blake, of the U. S. National Museum, returned to Washington on October 10 after spending the summer working in the California Academy of Sciences and in the Museum of Comparative Zoology at Cambridge, and in collecting in California, Arizona, and Wyoming. She is now working up the collected material with the aid of the Coleoptera collections in the National Museum.

Mr. George M. Greene of Harrisburg, Pa., has donated his valuable collection of insects to the National Museum. Mr. Greene began collecting in 1893, specializing in the Coleoptera. His collection contains about 48,000 specimens, 42,000 being Coleoptera, all well mounted, labeled, and determined. Messrs. H. S. Barber and C. T. Greene went to Philadelphia on October 28 and brought the collection to Washington by automobile.

Miss B. M. Broadbent, of the Bureau of Entomology, who has been in California temporarily assisting Dr. F. R. Cole on bulb-fly studies, left there the latter part of October to join the staff of the New Orleans laboratory. She will have with her all the accumulated records on the cyanide treatment of ornamentals and will review this entire field with Dr. C. I. Bliss and his associates.

Mr. C. F. Doucette, who has been in charge of the bulb-fly work of the Bureau of Entomology in the Northwest, arrived in Washington in October on his return from Europe where he attended the convention of the American Legion. He visited the bulb cultures of Holland and England, and learned much that will be of value in handling the bulb situation in this country.

Mr. Norman Criddle closed the Treesbank, Manitoba, laboratory for the winter on November 12, and en route to Ottawa stopped at Winnipeg for two days where he gave an address on the "Biological Control of Insects" before the Natural History Society of Manitoba. Mr. Criddle arrived in Ottawa in time to attend the annual meetings of the Ontario Entomological Society and the Branch conference.

Talks on insects were a feature of a meeting of the Louisiana Club of the U. S. Department of Agriculture held at New Orleans on January 5. Dr. A. C. Baker of the Bureau of Entomology addressed the club by special invitation. His subject was the Mexican fruit worm, with special reference to the eradication campaign in Texas. Mr. F. B. Milliken, entomologist of the grain export bureau, gave an account of his inspection of grain cars in New Orleans.

Messrs. A. O. Larson and C. K. Fisher of the Bureau of Entomology were located during October and the early part of November at Modesto, Calif., where, in cooperation with warehouse operators and the county horticultural commissioners, they examined nearly 2,000 samples of beans. It was found that from 5 to 85 per cent of the samples from the various storage houses were infested with bean weevils. An average of 39.8 per cent of all the samples from seventeen warehouses showed infestation in some degree.

Mr. William H. Thorpe, of the Zoological Laboratory of Cambridge University (England) spent a few days in Washington in the early part of November. He holds an International Education Board fellowship, and will spend the winter with Professor Harry S. Smith at the Citrus Experiment Station at Riverside, Calif., studying the problem of natural control. He expects to return to the East in the spring, stopping at different points of entomological interest, and the field laboratories of the Bureau may expect to see him. He hopes to attend the Fourth International Entomological Congress at Ithaca in the middle of August, 1928.

The following were among the visitors at the Gipsy Moth office or Parasite Laboratory, Melrose Highlands, Mass., in September and October: Dr. C. L. Marlatt and family, of Washington, D. C., Professor W. C. O'Kane, of New Hampshire, Professor R. A. Cooley of Montana, H. C. Hallock and H. A. Jaynes, of the Japanese Beetle Laboratory at Riverton, N. J., M. E. Ryberg, of the Bureau of Entomology, stationed at the Boyce-Thompson Institute, Yonkers, N. Y., C. H. Batchelder, of the European Corn Borer Laboratory, Arlington, Mass., and C. F. Doucette, of the Puyallup, Wash., field laboratory of the Division of Tropical and Subtropical Plant Insect Investigations. Mr. Doucette had just returned from his trip to Europe.

Mr. J. L. King recently spent a week in Raleigh, N.C., as a guest of Dr. Z. P. Metcalf, head of the Department of Zoology and Entomology, North Carolina State College of Agriculture, and while there had an opportunity to look over the college and the large card catalog and bibliography of the Hemiptera of the world, prepared by Dr. Metcalf. Mr. King also had an opportunity to spend three days on a field trip conducted by Dr. D. W. Wells, covering the entire coastal region from the Piedmont plateau to the shore. The six ancient terraces on the old shore lines were observed, and many interesting plant types were studied.

Dr. L. O. Howard retired as Chief of the Bureau of Entomology on October 17, and introduced to the Washington personnel his successor, Dr. C. L. Marlatt. At the request of both Dr. Howard and Dr. Marlatt the reception was very informal. Dr. Howard returned to Washington early in October after spending July, August, and September on official business in Europe. In England he visited the British

Museum of Natural History, the Rothamsted Experiment Station at Harpenden, the new Mosquito Control Institute at Hayling Island, the new parasite laboratory of the Imperial Bureau of Entomology at Farnham Royal, the Wellcome Field Laboratory at Wisley, and the Moltino Institute at Cambridge. In France, he visited Dr. Marchal's laboratory in Paris, the Pasteur Institute, and the laboratory of the U. S. Bureau of Entomology at Hyères. In Germany, he visited the Deutsches Entomologisches Institut and the Biologischen Reichs-Anstalt at Berlin-Dahlem, and Dr. K. Escherich's laboratories in Munich. He also visited Poland, Czechoslovakia, Austria, and Jugoslavia, and attended the Tenth International Zoological Congress at Budapest.

The sixty-fourth annual meeting of the Entomological Society of Ontario was held at Ottawa, in the Chateau Laurier Hotel, on November 17 and 18. The meetings, which were well attended by Branch officers from widely scattered parts of the Dominion, members of the provincial entomological services, a number of prominent entomologists from the United States, and others, have been described as constituting the most successful in the history of the Society. The entomologists from the United States included: Dr. L. O. Howard of the Bureau of Entomology, Washington; Dr. F. E. Lutz of the American Museum of Natural History, New York; Professor R. H. Pettit and Mr. B. R. Proulx of the Michigan State College of Agriculture and Applied Science, East Lansing; Mr. Loren B. Smith of the Japanese Beetle Laboratory, Moorestown, N. J.; Mr. D. W. Jones of the European Corn Borer Laboratory, Arlington, Mass., and Mr. Neale F. Howard, in charge of Mexican bean beetle investigations, Columbus, Ohio. During the course of the meetings, Dr. L. O. Howard gave an informal talk on "International Aspects of Entomology," and an interesting and informative illustrated public address on "What Economic Entomology Means to the World," at the Victoria Museum on November 17. The latter meeting was presided over by Dr. A. T. Charron, Assistant Deputy Minister of Agriculture.

Dr. J. M. Swaine returned to Ottawa on November 28, after four months' absence in Europe attending the International Zoological Congress at Budapest, the Imperial Agricultural Research Conference at London, and visiting entomologists and forests in various continental countries and Great Britain. In France, Dr. Swaine conferred with entomologists and foresters at Paris and the Forest School at Nancy. He also spent several days in company with French foresters inspecting the very fine spruce and fir forests in the Vosges area of eastern France. In northern Italy the splendid forest of Vallambrosa and the institutions and museums in Florence were also visited. The congress at Budapest, held September 5–9 inclusive, brought together about one hundred entomologists, chiefly from central and northern Europe, but also including seven entomologists from the United States, one from Canada, and several from Great Britain. Subsequent to the congress, in company with Dr. Walter Horn of Berlin, he visited the entomological museums of Vienna and Prague, and at each place entomological meetings were attended, greatly adding to the interest of the visit. The forestry schools at Tharandt and Eberswalde in Germany were visited, as well as the Entomological Museum in Berlin and the two institutions in Dahlem. German forests were visited, particularly in Saxony and in the Hartz Mountains. Several days were spent studying the Eggers forest insect collection at Stolberg. Four days were taken up conferring with Dr. Tragardh, Professor Spessivtseff, Dr. Kemner, and other entomologists and biologists in Stockholm. The entomologists and Entomological Museum at Copenhagen were also visited.

The 14th annual meeting of the Entomological Workers in Ohio Institutions was held on February 3, 1928 in the Botany and Zoology Building at Ohio State University, Columbus. An interesting program of 29 papers was presented, President L. L. Huber of the Ohio Experiment Station presiding. Corn borer research and extension was given the greatest emphasis, while the Teaching of Entomology, the Mexican Bean Beetle, the Oriental Fruit worm, the European Red Mite, and miscellaneous problems were discussed. Miss Annette F. Braun gave a very interesting discussion of "Some Remarkable Habits in the Microlepidoptera" which were the result of careful and patient observations of changes in feeding habits during the larval life of certain minute leaf mining Lepidoptera. Sixty-nine members and visiting entomologists were present. The following officers were elected for the 1929 meeting: President, Richard Faxon, State of Ohio Dept. of Agriculture, Columbus, Ohio; Vice President, Neal F. Howard, Bureau of Entomology, Columbus, Ohio; Secretary, G. A. Filinger, Ohio Agricultural Experiment Station, Wooster, Ohio.

NEALE F. HOWARD, *Secretary.*

Notes on Horticultural Inspection

Mr. Wallace S. Jones, plant quarantine inspector at Brownsville, Texas, resigned on October 31.

A revision of the European corn borer quarantine was signed by the Secretary on December 29, adding nearly eight hundred townships to the regulated area.

Dr. S. B. Fracker spent the month of November in the southwestern states studying the field activities of the Mexican fruit worm, pink bollworm, Thurberia weevil, and date palm scale control and eradication projects.

The satin moth quarantine was amended, effective October 18, 1927, adding 2,071 square miles in Maine, 121 square miles in New Hampshire, and 620 square miles in Massachusetts—a total of 2,812 square miles—to the regulated area.

Mr. G. H. Hecke, Director of the Department of Agriculture of California, visited the department in early December to discuss with the Secretary of Agriculture and with the Federal Horticultural Board the date palm scale eradication program and other matters.

Mr. Frank G. O'Donnell, an inspector of the Federal Horticultural Board, who has been stationed at the Inspection House in the District of Columbia for several years, died at his home in Clarendon, Va., on January 11, after a long illness.

A divisional conference of District Inspectors was held at Ottawa on November 26 immediately following the Branch conference. A number of points, principally in connection with inspection work, were discussed with a view to securing uniformity of procedure at the various ports.

In order to strengthen the Mexican Border inspection force, several new appointments have been made by the Federal Horticultural Board, including Freemont A. Ballou, assigned to Douglas, Arizona; I. W. Berryhill to Hidalgo, Texas; and George M. Jones to Laredo, Texas.

Mr. Lee A. Strong of the California Department of Agriculture, visited Washington in January, to discuss with members of the Federal Horticultural Board and Bureau of Entomology, the lines of work in which the Federal Department is cooperating with the State of California.

Under an amendment to the Japanese beetle quarantine, which became effective on November 1, 1927, parts of ten counties in Pennsylvania, two entire counties in New York and part of one county in Connecticut were added to the area designated as regulated on account of this pest.

According to Mr. E. C. Mandenberg, State Inspector of Orchards and Nurseries for the Michigan Department of Agriculture, that department has undertaken the inspection of Christmas trees shipped from Michigan points, primarily to prevent the spread of the spruce gall aphid and the spruce budworm.

The Federal Horticultural Board reports the following transfers: L. A. Frost, from New York City to Hidalgo, Texas; L. R. Dorland, from Nogales, Arizona, to take charge of the port of Galveston, Texas; C. P. Trotter, from Galveston, Texas, to San Juan, Porto Rico; C. E. Bellis, from Douglas, to take charge of the port of Nogales, Arizona.

The latter part of December, Mr. J. M. Corliss of the Office of Blister Rust Control, discovered that white pine branches which had been transported into Illinois from Michigan and Wisconsin in violation of the Federal white pine blister rust quarantine were being used as Christmas decorations in Chicago. The material was later burned under Mr. Corliss' supervision

Owing to the fact that December was unusually mild, narcissus blossoming is considerably advanced, and the narcissus inspections were made in the Gulf States several weeks earlier than usual. Mr. A. J. Bruman of the Federal Horticultural Board spent December and January in Florida making examinations of the plantings of bulbs which had been imported under special permits.

An appropriation of $25,000 to expand the date palm scale eradication program was made in the first deficiency bill of the present Congress. This amount became available late in December. Mr. B. L. Boyden, Sanford, Fla., is being transferred from the Bureau of Entomology to the Federal Horticultural Board to take charge of this work, and expects to move to Indio, Calif., for that purpose, early in February.

The Section on Plant Quarantine and Inspection met at Nashville, Tenn., on Tuesday, December 27, with a large number of inspectors from all parts of the United States in attendance. The meeting was devoted largely to reports of the regional plant boards and the National Plant Board, and to a symposium on the work of the Federal Horticultural Board, especially the quarantines affecting interstate movement of plant material.

A large scale clean-up campaign directed against pink bollworm infestations in southwestern New Mexico and in eastern Arizona is under way. Over nine thousand acres of cotton fields are included in the clean-up operations and about one thousand men are employed as laborers in the work. The growers are giving hearty cooperation and support to the work, which it is hoped will eventually result in the total eradication of the pink bollworm from this area. Mr. M. H. Ford is in charge in the field.

Changes recently made in California plant quarantine regulations include: A revision of Amendment No. 1 to the alfalfa weevil quarantine order, effective December 23, 1927, adding Inyo County, California, to those into which alfalfa products may be transported from Douglas County, Nevada, under certain restrictions; regulations to prevent the intrastate spread of three species of strawberry root weevils, a vegetable weevil (*Listroderes obliquus* Gyll.) and the citrus white fly.

The first deficiency bill included an item of $100,000 to cover the eradication, control, prevention of spread, and investigations of the Mexican fruit worm in the Rio Grande Valley of Texas. Up to the end of December no fruit worms had been found in this season's citrus crop. Dr. A. C. Baker, in charge of Tropical and Subtropical Insect Investigations of the Bureau of Entomology, is now traveling in Texas and New Mexico, supervising the administration of the fruit worm quarantine, in co-operation with the Federal Horticultural Board.

Following the discovery in 1926 that some of the chestnuts arriving from Italy were infested with a European codling moth (*Laspeyresia splendana*), the Federal Horticultural Board notified the importers that chestnuts must either reach the ports of entry free from infestation or treatment upon arrival would be required. Such treatment at the point of origin was undertaken under the supervision of Italian entomologists for the past shipping season. The first shipments received were found free from infestation, but several later lots showed both codling moth and weevil larvae, and a hot water treatment at New York was required.

The scouting crews of the pink bollworm field service have been enlarged on account of the discoveries of new infestations in New Mexico and Arizona last year, and more time and effort have been expended this season in attempting to discover infestations in the western half of the main cotton belt. While pink bollworms have been found in each of the regions previously known as infested, no new infested areas have been discovered this season. In addition to the employment of a large number of temporary men, the Board has made the following appointments to the regular force: Madimore Brunson, Kenneth A. Gallant, A. K. Inman, and Marshall W. Stone.

Mr. Max Kisliuk, Jr., returned in late December from Spain, where he has been conducting a resurvey of the fruit fly situation as affecting the Malaga grape in Almeria. The resurvey revealed that the Mediterranean fruit fly still exists throughout the grape districts of Almeria, including the areas where more or less intensive clean-up operations were undertaken. No modification of the action of the Department in excluding such grapes from the American market is therefore contemplated. Mr. Kisliuk also made an investigation of the tomato industry of the Canary Islands but failed to find any infestation of tomatoes by fruit flies or other injurious insects, although the Mediterranean fruit fly was abundant there in oranges and other fruits.

Apicultural Notes

Mr. James I. Gwin has been appointed a honey marketing specialist by the Wisconsin Bureau of Markets. As president of the State Beekeepers' Association Mr. Gwin has been exceedingly active for the past three years.

Professor V. G. Milum, in charge of beekeeping at the University of Illinois, was recently elected secretary of the Illinois State Beekeepers' Association. Dr. A. C. Baxter of Springfield was re-elected president of the Association.

Announcement has recently been made of the resignation of Professor Francis Jager as head of the Division of Bee Culture of the University of Minnesota during the current year, when he will have completed fifteen years of service. The service which Professor Jager has rendered beekeepers during this period is too well known to beekeepers throughout this country and abroad to be dwelt upon here.

Mr. W. J. Nolan, of the Bee Culture Laboratory of the Bureau of Entomology, attended the meeting of the Illinois State Beekeepers' Association at Springfield, and the meeting of the Wisconsin State Beekeepers' Association at Milwaukee the beginning of December. He also attended the meetings of the Apicultural Section of the American Association of Economic Entomologists held at Nashville, Tenn., during Christmas week.

Mr. C. E. Burnside, of the Bee Culture Laboratory of the Bureau of Entomology, has discovered in the blood of the adult honeybee an organism which he has named *Bacillus apisepticus*, which causes Septicemia in adult honeybees. An account of this discovery was given before the Apicultural Section at the Nashville Meeting in December. At the same meeting the paper by Dr. J. W. Bulger, of the Bee Culture Laboratory, describing the discovery of the amoeba disease of the adult honeybee in the United States was also presented. This discovery was first announced in the Official Record of the United States Department of Agriculture on July 20.

During the months of January and February, Mr. E. L. Sechrist, of the Bee Culture Laboratory of the Bureau of Entomology, attended a series of beekeepers' meetings which took him to the Pacific Coast. His schedule included meetings of various organizations as follows: The Maryland Horticultural Society, at Baltimore, January 3; the Short Course given by the University of Illinois at Urbana, January 11–12; Heart of America Beekeepers' Association, Kansas City, Missouri, January 14; Oklahoma Beekeepers' Association, Kansas City, Missouri, January 14; Oklahoma Beekeepers' Association, Oklahoma City, January 16–17; Arkansas Beekeepers' Association, Little Rock, January 18 19; Southern States Conference consisting of Oklahoma, Texas, Louisiana, and Arkansas, at Texarkana, Ark., January 20–21; conference with marketing specialists on honey grades at Los Angeles, Calif., on January 24; the annual meeting of the American Honey Producers' Association at San Francisco, Calif., on January 25–27; the Intermountain Bee Culture Field Station at Laramie, Wyo., on January 31; the short course during Farmers' Week at the University of Iowa at Ames, on February 2–4; and the short course at the University of Kansas, Manhattan, on February 8–9.

Notes on Medical Entomology

Mr. R. Glendenning made an airplane survey of the Harrison Lake mosquito breeding areas near Agassiz, B. C., on October 16, and was able to secure several excellent aerial photographs.

The fifteenth annual convention of the New Jersey Mosquito Extermination Association is scheduled to be held at the Hotel Chalfonte-Haddon Hall, Atlantic City, N. J., February 15, 16, and 17.

Dr. W. V. King, of the Bureau of Entomology, attended the meeting of the National Malaria Committee at Memphis, Tenn., on November 16 and 17. Dr. King is chairman of the subcommittee on entomology.

Dr. F. M. Root of Baltimore recently called at the Division of Insects, U. S. National Museum, and obtained Dr. H. G. Dyar's assistance in determining some of his mosquito collections from Venezuela.

Professor R. A. Cooley of Montana State College, Bozeman, Mont., visited the Division of Insects, U. S. National Museum, on November 2 and 3, and examined tick parasites belonging to the genera *Ixodiphagus* and *Hunterellus.*

Mr. Raymond C. Shannon, who has been engaged in a mosquito survey of Argentina for the past two years, returned to Washington early in December. He has accepted a six months' assignment in Peru under the Rockefeller Foundation, to undertake an investigation of the transmission of Verruga by insects, and will sail from New York on January 26.

ENTOMOLOGICAL SOCIETY OF PENNSYLVANIA

The Fifth Annual Meeting was held at Harrisburg, January 17th, conjointly with the State Farm Products Show. The morning session and part of the afternoon was devoted to a conference of the Oriental Fruit Moth workers of Pennsylvania and adjoining states. Dr. H. L. Dozier addressed the conference on the subject of the relation of Taxonomic to Economic Entomology. An opening meeting was held in the auditorium during the afternoon, at which Mr. R. H. Bell explained the status of the Corn Borer in Pennsylvania, Mr. C. C. Hill discussed the present Hessian fly situation in the state, Mr. G. B. Stichter presented data concerning the Japanese Beetle and methods of handling the quarantine on this pest, and Mr. J. N. Knull gave information concerning the Mexican Bean Beetle and its spread in Pennsylvania. Following the afternoon session the society adjourned for supper at the University Club. In the evening Dr. E. H. Dusham gave an address on the history of dusting for the control of apple insects, and Dr. J. L. King gave an illustrated talk on the methods of handling parasites in connection with Japanese Beetle control work. Among the visiting entomologists present were, Dr. A. H. Peterson, Dr. T. J. Headlee, Dr. B. F. Driggers, Mr. J. W. Lipp, and Mr. G. T. Haeussler, of New Jersey; Dr. E. N. Cory, Mr. P. D. Sanders, and Mr. H. S. McConnell, of Maryland; Dr. Philip Garman, of Connecticut; Dr. H. L. Dozier, of Delaware; Dr. J. S. Houser, and Mr. L. A. Stearns, of Ohio; Mr. W. A. Ross, of Canada; Dr. J. L. King, of the Federal Bureau of Entomology. Officers for the ensuing year were elected: President, Mr. C. C. Hill; Secretary, Dr. E. H. Dusham.

C. C. HILL, *Secretary*

ERRATA

On page 710, line 28, of the October, 1927, issue, insert "March" for "April," and line 29, insert "March" for "April." These lines would then read—"Larvae were found in the soil evidently preparing to pupate on March 7. The first puparium was found March 13 and the last larva April 7."

On page 791 in the December, 1927, JOURNAL, the last column (Grubs per sq. ft.) in Table 7 should read 0.6, 0.0, 0.8, 1.3, and 0.0 instead of 3, 0, 4, 6.5, and 0. The correction is important for quantitative work but not for qualitative purposes.

On pages 796 and 800, figures 36 and 37, the illustrations only should be transposed.

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(*Continued*)

Friday Morning Session, December 30

The meeting convened at 9:40 o'clock, First Vice-President W. P. Flint in the Chair.

FIRST VICE-PRESIDENT W. P. FLINT: The first paper on the program this morning is by J. W. McColloch and W. P. Hayes.

ECOLOGICAL STUDIES OF KANSAS SCARABÆID LARVÆ (COLEOP.)[1]

By WM. P. HAYES and J. W. MCCOLLOCH

ABSTRACT

A collection of 18,781 scarabæid larvæ made in Kansas during a period of eight years includes 37 species representing 17 genera. Seventeen species of the genus *Phyllophaga* are considered. The data included show the percentage of rearing mortality, the seasonal distribution, relative abundance, habit at preferences, food habits and parasitism by *Tiphia* wasps.

INTRODUCTION

During the course of a series of biological studies of the family Scarabæidæ carried on at the Kansas Agricultural Experiment Station, Manhattan, Kansas, considerable data were amassed on the relative numbers, as well as the habitat and food preferences of larvæ of various common species of this family. Since they are of general ecological and biological interest the statistical results of these studies are presented here.

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[1] Contribution No. 364 of the Department of Entomology of the Kansas State Agricultural College and No. 118 of the Department of Entomology of the University of Illinois. This paper embodies some of the results of Project No. 100 of the Kansas Agricultural Experiment Station.

Collections of larvæ of this family of beetles were begun in 1916 and extended over a period of eight years, to and including 1923. The specimens collected were transported to the laboratory and reared to the adult stage in individual salve boxes in an underground cave. Because of the difficulty in rearing, and in some cases the presence of a long life cycle, the relative proportion of those reared to adult, for determination of the species, compared to the numbers collected in the field shows that less than one-third of the total were so reared. During the eight years 18,781 grubs were collected, of which 5,884 were matured under artificial conditions. Among these 5,884 reared specimens, 17 genera are involved with a total of 37 species. The largest number of species belonging to a single genus are represented by 17 species of the genus *Phyllophaga*. The other 16 genera distributed among the various subfamilies of Scarabæidæ contain but one, two, three or four species.

With but very few exceptions, these larvæ were collected in the vicinity of Manhattan, Kansas. Numerous student assistants have aided in the work, both in collecting and rearing, to whom the writers acknowledge their indebtedness.

PERCENTAGE OF MORTALITY IN REARING

Because of the difficulty of determining the various species in the immature stages, the data here discussed are based on those species actually reared and identified instead of on the total numbers collected. Such a condition would not be necessary if we were able to identify specifically each specimen collected. Table 1 shows the total individuals collected in each of the eight seasons as well as the numbers reaching maturity and the percentage of those reared. In other words, the table is an indication of the percentage of mortality in rearing as shown in the last column.

TABLE 1. SHOWING THE PERCENTAGE OF REARING AND MORTALITY OF SCARABÆID LARVAE

Year	Total Numbers Collected	Total Numbers Reared	Percentage of Rearing	Percentage of Mortality
1916	716	270	37.7	62.3
1917	251	99	39.4	60.6
1918	814	302	37.1	62.9
1919	790	372	47.0	53.0
1920	4004	1431	33.2	66.8
1921	3044	630	20.6	79.4
1922	3617	1508	41.6	58.4
1923	5545	1272	22.8	77.2
Total	18781	5884	31.3	68.7

From the foregoing data it is apparent that only 31.3 per cent of all grubs collected were reared to maturity, giving a mortality of 68.7 per cent. It is interesting to note that the mortality for each year did not show a wide variance. The percentage of reared specimens for the eight years shows a variation of from 20.6 per cent to 47 per cent.

The smallest collection was made in 1917 when 251 larvæ were collected while in 1923, 5545 individuals were obtained. The fact that specimens collected in any one season do not always mature that particular season or even the next year must be borne in mind. This is because of the various lengths of the life-cycle in the different species. For example, specimens collected in 1917 may have some individuals, no matter what the length of the life-history, maturing in 1917, others in 1918 and still others in 1919 which, of course, is also due, in part, to the overlapping of the various broods.

THE COLLECTIONS OF THE GENUS *Phyllophaga*

Seasonal Distribution.—The following discussion of the various collections, for convenience, is divided into two groups. The genus *Phyllophaga* with 17 species represented will be considered as one unit while the remaining 16 genera will be considered jointly. Table 2 shows the various species as to the year in which they were collected and not the year of maturity. The order of arrangement is based on numbers collected and not on their relationships.

TABLE 2. SHOWING THE COLLECTIONS OF PHYLLOPHAGA AS DETERMINED BY REARING

Species of *Phyllophaga*	Year of Collection								
	1916	1917	1918	1919	1920	1921	1922	1923	Total
P. crassissima	15	36	40	33	196	52	18	6	396
P. rubiginosa	11	7	15	22	10	41	25	4	135
P. rugosa	14	4	9	33	22	24	14	5	125
P. lanceolata	2	16	9	50	1		1		79
Pl submucida		2	2				66	9	79
P. implicita	6	4	4	8	20	1	28	5	76
P. hirticula var. *comosa*		2			4	18			24
P. praetermissa ...			3		8			2	13
P. longitarsa		1	4				3		8
P. bipartita			1	3				2	6
P. futilis					3			2	5
P. corrosa			2			1		2	5
P. glabricula		2						3	5
P. fusca						3			3
P. crenulata			1				1		2
P. tristis	1							1	2
P. affabilis						1			1
Total	49	74	90	149	264	141	156	41	964

As shown in Table 2, there were a total of 964 individuals representing 17 species reared from the total of 18,781 (See Table 1) grubs of all species collected. Of course, many individuals of this genus failed to live through the rearing period so a percentage of those reared based on the number collected would be unfair. However, the percentage reared based on the total species gives an inkling of the relative proportions of *Phyllophaga* to other species of the family. Of the total (5,884) beetles, only 964 or 16.3 per cent belonged to this genus. Neither Table 1 nor Table 2 shows any evidence of the presence of the definite broods (Brood A, B, and C) which have been long known through the various collections of adults. However, Table 2, as indicated in the column of totals, offers further data on the relative numbers of the various species found in the locality considered. Of the total of all species (964) reared, *P. crassissima* ranks first with a total of 396 individuals or about 41 per cent; *P. rubiginosa* ranks second with about 14 per cent and *P. rugosa* nearly 13 per cent.

Relative Abundance.—If we compare the individual total of each species with the total adults collected during the first seven years (1916–1922) of the eight during which this study was in progress,

TABLE 3. SHOWING A COMPARISON OF THE RELATIVE ABUNDANCE OF *Phyllophaga* ADULTS AND REARED LARVÆ

Rank	Species of *Phyllophaga*	Total Larvae Reared	Adults Collected 1916–1922	Comparative Ranking of Adult Abundance
1	*P. crassissima*	396	31,966	First
2	*P. rubiginosa*	135	15,130	Third
3	*P. rugosa*	125	4,010	Fifth
4	*P. lanceolata*	79	15,851	Second
5	*P. submucida*	79	57	Eighteenth
6	*P. implicita*	76	982	Tenth
7	*P. hirticula* var. *comosa*	24	1,696	Ninth
8	*P. praetermissa*	13	115	Sixteenth
9	*P. longitarsa*	8	909	Eleventh
10	*P. bipartita*	6	3,523	Seventh
11	*P. futilis*	5	10,362	Fourth
12	*P. corrosa*	5	3,732	Sixth
13	*P. glabricula*	5	440	Twelfth
14	*P. fusca*	3	135	Fourteenth
15	*P. crenulata*	2	127	Fifteenth
16	*P. tristis*	2	114	Seventeenth
17	*P. affabilis*	1	44	Nineteenth
18	*P. vehemens*	0	2,001	Eighth
19	*P. congrua*	0	135	Thirteenth

(Table 3) some interesting facts are brought out. The most abundant species among the adults collected, (*P. crassissima*) is seen to be the most numerous among those species collected as grubs. *P. lanceolata* while second in number of adults is fourth in the grub collections. This may be, in part, due to the slightly longer life-cycle of *P. lanceolata* (Hayes, 1919).[2] *P. rubiginosa* while third among the adults was second among the grubs and *P. rugosa* was fifth in the beetle collections and third among the larvae. On the whole, these four important species rank very close while greater differences are disclosed among the other species. An interesting observed fact is that more individuals of *P. submucida* were collected as grubs and reared to adult than were taken in the adult collections. The two species, *P. vehemens* and *P. congrua*, which ranked eighth and thirteenth, respectively, in the adult collections, were not reared from grubs.

COLLECTIONS OF OTHER GENERA

Seasonal Abundance.—In addition to the collections of *Phyllophaga*, 20 species representing 16 other genera of the family Scarabæidæ are available for comparison with the genus *Phyllophaga*. These were, for the most part, incidental to the white grub collections but, since all that were found were collected, the data available show the years of abundance as well as the relative numbers. These data are summarized for the various species and the years in which they were collected in Table 4. It will be noted that the two most numerous species are *Ochrosidia* (*Cyclocephala*) *immaculata* (Oliv.) and *Ligyrus gibbosus* (DeG.). The numbers of *Ochrosidia* reared far outnumber those of any other species, being represented by 3070 individuals. Comparing the number of *Ochrosidia* with those of *Phyllophaga* (Table 2) it will be noted that over three times as many *Ochrosidia* were collected and reared as all *Phyllophaga* combined, whose total figure is 964. It must be borne in mind, however, that the one year life-cycle of *Ochrosidia* compared to the two and three year cycles of *Phyllophaga* makes rearing much easier with less mortality. Space does not permit a discussion of all the facts apparent in Table 4, but it will be noted that the collection contains representatives of the most important sub-families of the Scarabæidæ.

If the total collections of *Ochrosidia* are summarized by months for the various years, as is done in Table 5, a striking feature is the almost complete absence from the soil of larvæ during June with relatively few

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[2] Hayes, W. P. The life cycle of *Lachnosterna lanceolata*. *In* Jour. Econ. Ent. 12:109–117, 1919.

TABLE 4. SHOWING A COMPARISON OF THE RELATIVE ABUNDANCE OF SCARABÆID LARVÆ OTHER THAN *Phyllophaga* SPP.

Miscellaneous Species of Scarabæid Larvæ	Year of Collection 1916	1917	1918	1919	1920	1921	1922	1923	Total
Ochrosidia immaculata	32	2	155	155	723	315	973	715	3070
Ligyrus gibbosus.....	5	17	2	2	227	23	116		392
Anomala binotata.....	145	4			37	42	47	27	302
Anomala kansana....			3	1	154	4	57	37	256
Anomala innuba.....	1		9	45	21		15	53	144
Anomala undulata....							7	1	8
Cotalpa lanigera.....						1	23	125	149
Pelidnota punctata....		2	10	1	1	7	5	92	118
Ligyrodes relictus.....	13		10	19	1	74	6		123
Euphoria inda.......	25				1	14	6		46
Euphoria sepulchralis.			1			4	2	2	9
Aphodius sp.........								53	53
Canthon laevis.......						4			4
Trox sp............								122	122
Polymoechus brevipes..							12		12
Cremastocheilus nitens			20				1		21
Ataenius inops......							81		81
Trichiotinus piger....			2		2	1		3	8
Stephanucha pilipennis							1		1
Polyphylla hammondi.								1	1
Total...... ..	221	25	212	223	1167	489	1352	1231	4920

present in July. This fact is explained and correlated with the life history of the species for during these months the adult stage is found both in the soil by day and at lights at night. The collections of grubs

TABLE 5. SHOWING THE MONTHLY ABUNDANCE OF *Ochrosidia immaculata* FOR THE YEARS 1916 TO 1923

Month	1916	1917	1918	1919	1920	1921	1922	1923	Tota
January............								26	26
February...........						1			1
March.............	13			16	2			4	35
April..............	4		11	14	146	35	43	101	354
May...............	3		12	27	15		91	20	168
June..............							5		5
July...............			9		4	72		1	86
August............	5	1	28		317	199	671	522	1743
September..........	7	1	56	70	232	8	100	32	506
October............			39	28	7		31	5	110
November..........							2		2
December..........							30	4	34
Total............	32	2	155	155	723	315	973	715	3070

made in June are individuals hanging on from the old generation just maturing while those of July are usually young larvæ which have recently hatched.

HABITAT PREFERENCE OF ALL SPECIES

The various sources of the collections were grouped into 12 categories and the numbers collected and those reared from these places are summarized in Table 6. It is apparent that wheat land is the preferred type of soil, inasmuch as 7,912 grubs were taken in such land compared to 1,749 grubs in blue grass sod and lawns. The following habitats are represented by over 1,000 specimens each; oat land, corn land, and under or in logs and stumps. In view of the fact that grubs are said to prefer sod land, it is surprising to find grubs as numerous as they were in wheat land which is usually plowed each year in the general vicinity of Manhattan, Kansas. Nevertheless, in the consideration of such data it must be remembered that collections are more easily made in land disturbed more frequently than sod land. The numbers, however, are so strikingly different that they must have some significance. The collections listed under "Logs and Stumps" were mostly *Pelidnota punctata* (Linn.) but also includes species like *Trichiotinus piger* (Fab.) which lives in logs and also some miscellaneous species found in the soil under logs.

The following situations are included under the heading "Miscellaneous" and the number of grubs taken from each is given:—weeds 405, sumac 5, bindweed 131, sunflower 53, strawberry 26, rhubarb 6, sorghum 58, petunia 1, ironweed 3, Johnson grass 8, cabbage and rape 85, tree nursery 8, dock, 19, agronomy small gain nursery 84, hay stack 5, straw stack 25, cowpeas 73, grass roots on sand dunes 1, pigweed 1, sudan grass 13, campfire wood ashes 45, brome grass 15, under dead horse 301. The figures above are the total numbers collected and not the total of those reared.

FOOD PREFERENCE

Food Preference of Phyllophaga.—While the data in Table 6 show the habitat preferences of the various species as a whole, they do not show the individual preference of the different species. The apparent choice of the various species of *Phyllophaga* is shown in Table 7 and those of other genera in Table 8.

In Table 7 it is shown that the most individuals of *Phyllophaga* were taken in blue-grass sod where 234 specimens were found. The next in

TABLE 6. SHOWING THE HABITAT PREFERENCE OF ALL SPECIES

Habitat	1916		1917		1918		1919		1920		1921		1922		1923		Total	
	Col.	Reared	Col.	Reared	Col.	Reared	Col.	Reared	Col.	Reared	Col.	Reared	Col.	Reared	Col.	Reared	Col.	Reared
Wheat.....	123	36	17	11	24	18	202	76	1728	746	459	110	2030	860	3329	657	7912	2514
Blue Grass Lawns...	85	15			152	32	8	4	1404	199	9	1	87	25	4	3	1749	279
Oats......	312	144			2	2			239	144	610	93	193	106	194	37	1550	526
Corn......	44	26	103	41	215	118	264	135	274	195	48	10	281	139	165	80	1394	744
Logs and Stumps..			2	2	221	75	3	3	6	3	43	9	40	15	886	107	1201	214
Pasture....	40	8	49	13	141	21	24	15	3	3	65	26	13	7	195	62	530	155
Manure....	78	37	9	2	18	12	89	23			388	97	194	76	170	63	946	310
Orchard...	4	1	1	1			1	1			37	4	93	10	56	37	192	54
Alfalfa.....							8	3	85	21	805	150	61	21	62	22	1021	217
Potatoes...					9	6	1	1	53	15	315	35					378	57
Garden....	5	2			31	17	103	61	45	26	93	22	115	46	146	64	538	238
Miscellan.	25	1	70	29	1	1	87	50	167	79	172	73	510	203	338	140	1370	576
Total....	716	270	251	99	814	302	790	372	4004	1431	3044	630	3617	1508	5545	1272	18781	5884

TABLE 7. SHOWING THE FOOD PREFERENCE OF *Phyllophaga* GRUBS

Species of *Phyllophaga*	Wheat	Blue Grass and Lawns	Oats	Corn	Logs and Stumps	Pasture	Manure	Orchard	Alfalfa	Potatoes	Garden	Miscellaneous	Total
P. crassissima	23	202	7	45		9	2	2	19	5	45	37	396
P. rubiginosa	10	16	1	18	2	16	1	1	16	20	14	20	135
P. rugosa	18	4	6	19		3			6	19	36	14	125
P. lanceolata	45	1		5		26	1					1	79
P. submucida	7		2	6	1	3	56				1	3	79
P. implicita	10	1	3	44	1		1	1		2	4	9	76
P. hirticula var. *comosa*	5		9	2		1			6			1	24
P. praetermissa	2	8				3							13
P. longitarsa	3				5								8
P. bipartita	1				1	4							6
P. futilis		2			1				1			1	5
P. corrosa	1					4							5
P. glabricula						4						1	5
P. fusca	1		1						1				3
P. crenulata				1							1		2
P. tristis						1	1						2
P. affabilis									1				1
Total	126	234	29	140	11	74	62	4	50	46	101	87	964

preference is corn land with 140 individuals which is closely approached by the 126 larvæ taken from wheat. Pasture land with 74 grubs ranks fifth and probably to this type of food should be added a majority of those listed under the heading "manure" which in many cases was located on pasture land. It is perceivable that *crassissima*, *rubiginosa*, *implicita* and *rugosa* are quite generally distributed, while *lanceolata* shows a preference for wheat first and pasture sod second. The majority of the 56 grubs of *submucida* taken under manure were in pasture land. This species seems to have a preference for the upland soils of the region. The data on the other species are limited but from adult collections it is known that *longitarsa* and *prætermissa* prefer the sand hill regions along the Kansas river while *tristis* is usually taken near the oaks growing on the uplands along Wildcat creek.

The food preferences of other larvæ of the family Scarabæidæ are indicated in Table 8. In the total numbers reared wheat shows a predominance of individuals with oats and corn following in the order given. Analyzing the data by species brings out some interesting points. *Ochrosidia immaculata* is taken far more abundantly in wheat

TABLE 8. SHOWING THE FOOD PREFERENCE OF OTHER SCARABÆID LARVÆ

Species	Wheat	Blue Grass and Lawns	Oats	Corn	Logs and Stumps	Pasture	Manure	Orchard	Alfalfa	Potatoes	Garden	Miscellaneous	Total
Ochrosidia immaculata	1787	32	143	479	49	79	10	3	141	10	138	199	3070
Ligyrus gibbosus	125		189	17		4	11	2	19		1	24	392
Anomala binotata	122	2	164	4		1						9	302
Anomala kansana	235	1	2	8	2	1			1	1	2	3	256
Anomala innuba	5		70			48		12				9	144
Anomala undulata		8											8
Cotalpa lanigera	113			28			1		6			1	149
Pelidnota punctata	2				114						1	1	118
Ligyrodes relictus		1				2	120						123
Euphoria inda			1				41					4	46
Euphoria sepulchralis						3	6						9
Aphodius sp							53						53
Canthon laevis						4							4
Trox sp												122	122
Polymoechus brevipes					9		2					1	12
Cremastocheilus nitens					21								21
Ataenius inops							4					77	81
Trichiotinus piger					8								8
Stephanucha pilipennis						1							1
Polyphylla hammondi					1								1
Total	2389	44	569	536	204	143	248	17	167	11	142	450	4920

than elsewhere although it occurs rather abundantly in corn and oats. The adults apparently show a preference for land that is frequently plowed. *Ligyrus gibbosus* exhibits the same preference being found in oats and wheat while corn land is not so favorable. The same can be said for *Anomala binotata* while *A. kansana* occurs more frequently in wheat. *Cotalpa lanigera* occurs in wheat and corn usually in the sand hill area. Davis[3] has reported this species doing considerable damage to raspberry bushes, strawberries, corn and grasses.

The following species live in fallen logs and stumps:—*Pelidnota punctata*, *Polymœchus brevipes*, *Trichiotinus piger* and *Polyphylla hammondi*. The table shows 21 individuals of *Cremastocheilus nitens* taken from logs. These were in ant nests on the surface of the soil under a log on the sand dunes. Several species show a preference for manure and decaying vegetation such as rotten hay or straw stacks. Among these are *Ligyrodes relictus*, *Euphoria inda*, *Euphoria sepulchralis*, *Atænius inops* and *Aphodius sp.* The 122 individuals of *Trox sp.* listed under miscellaneous were taken from under a dead horse.

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[3] Davis, J. J. Common White Grubs. U. S. Dept. Agr. Farmers' Bull. 940:1-28. figs. 21. 1918.

COLLECTIONS OF LARVÆ PARASITIZED BY *Tiphia spp.*

The various species of *Tiphia* (Tiphiidæ, Hym.) attacking scarabæid larvæ account for the death of many individuals. During the course of these collections numerous grubs parasitized by Tiphia were collected and the parasite reared to adult. No attempt, so far, has been made to determine the various species. However, each parasite accounted for the death of one scarabæid larva. These grubs are not included in the foregoing data, but have been considered separately and are shown in Table 9.

TABLE 9. SHOWING THE COLLECTIONS OF SCARABÆID LARVÆ PARASITIZED BY *Tiphia Spp.*

Place Collected	1916	1917	1918	1919	1920	1921	1922	1923	Total
Wheat............	3			1	22		20	191	237
Sod............			4		45				49
Manure............	34								34
Oats............							13	11	24
Under logs..........			6						6
Pasture............			1		1		1		3
Corn............			1	1					2
Alfalfa............						1		1	2
Orchard............						1			1
Miscellaneous.......					1				1
Total............	37	0	12	2	69	2	34	203	359

Of the 359 parasitized grubs, 237 were collected in wheat land, 49 in sod and 34 in or under manure. Oat land yielded 24 parasitized grubs. It is apparent that adult *Tiphia* prefer to attack grubs in plowed land, as shown by the numbers taken in wheat and oats, rather than in soil that is packed more firmly.

SUMMARY

A study of the collections of 18,781 scarabæid larva over a period of eight years in addition to 359 parasited grubs indicates a rearing mortality of 68.7 per cent. Of the 31.3 per cent reared 964 belong to the genus *Phyllophaga* and the remaining 4,920 specimens matured belonged to 20 species of various genera of the family Scarabæidæ. The seasonal distribution of the various species is shown, as well as their relative abundance. The collections of *Ochrosidia* (*Cyclocephala*) show a correlation between their presence in the soil and their life history as previously determined by rearing. The habitat preferences of all species are indicated which show, in several instances, a preference for unplowed soil, contrary to the older, accepted statements, that hard, packed soil is more to their liking. The food preferences of the 37 species, as brought out by the studies show some interesting facts as regards the kinds chosen. In addition, the data on the grubs parasitized by *Tiphia spp.* indicate that the parasite is more abundant in plowed soils than in sod land.

MR. L. O. HOWARD: I would like to ask why there is more infestation in cultivated soil than in uncultivated soil.

MR. J. W. MCCOLLOCH: I presume that is associated with the greater ease with which the adult can get into the ground. That is the interpretation put on it at the present time.

MR. ARTHUR GIBSON: Have you found the parasite Microphthalma in great abundance?

MR. J. W. MCCOLLOCH: No.

MR. ARTHUR GIBSON: This parasite is quite common in certain sections of eastern Canada including Quebec.

MR. J. W. MCCOLLOCH: We have only two or three records of that.

MR. C. L. METCALF: How did the Tiphia parasitism compare in cultivated and uncultivated soils?

MR. J. W. MCCOLLOCH: As near as we can tell it was about the same. In fact, in some cases we got a little higher parasitism in cultivated soil. That may be due to the fact that the grubs were more abundant in the soil.

MR. L. O. HOWARD: Would it attack any white grub?

MR. J. W. MCCOLLOCH: We have not been able to run our various species of Tiphia down. We have a mass of material on hand now and we hope to get that done within the next year. Apparently they are the same species, and they attack the different grubs in the same place, which is more or less of a specific character.

FIRST VICE-PRESIDENT W. P. FLINT: The next paper is by A. A. Granovsky.

ALFALFA "YELLOW TOP" AND LEAFHOPPERS[1]

By A. A. GRANOVSKY, *University of Wisconsin*

ABSTRACT

The purpose of this paper is definitely to record in entomological literature some of the observations and experimental data, which proved beyond a doubt that the common potato leafhopper, *Empoasca fabae* (Harris), is responsible for the symptoms known as alfalfa "yellows" or "yellow top."

Healthy alfalfa plants in the field and in the greenhouse were caged and infested with leafhoppers collected from the affected alfalfa plants in the field.

The initial symptoms on older plants were produced in five days of leafhopper feeding. The young seedlings showed wilting from 24 to 36 hours after the confinement of a single nymph on a young succulent shoot of alfalfa seedling. Prolonged feeding resulted in badly discolored, stunted plants, while the young seedlings were often killed outright.

The root system of the infested plants was found to be weakened, which is considered an important contributing factor in the winter killing of alfalfa seedings.

Alfalfa "yellows" or "yellow top" has been considered a disease of an unknown cause and is looked upon as one of the oldest and most perplexing troubles of the alfalfa plant. For the last twenty years it has been reported from year to year as occurring mostly in the eastern half of North America. Only a few fragmentary references are found from the alfalfa growing belt of the arid regions.

Earlier workers observed that the second and third alfalfa cuttings suffer the most and that the affected plants are characterized by a gradual discoloration of the apical leaves, usually identified by the pale yellowing, which in time becomes more intense until it reaches an orange yellow color with a purplish tinge. The upper leaves and young shoots lose their fresh green color much more rapidly than the lower leaves. The discolored leaves do not drop, but remain on the plants throughout the growing season and produce a conspicuous diseased effect on the alfalfa foliage. The affected plants produce a poor growth which usually results in a great reduction in the yield of alfalfa hay.

The economic aspect of the problem was recognized as early as 1907. Since that time a number of agronomists and especially plant pathologists have paid particular attention to this trouble with alfalfa. After considerable effort to isolate a causal organism from the affected portions of the plants, it was evident that neither fungous nor bacterial organisms could be found constantly associated with the symptoms. As a consequence, alfalfa "yellows" has been attributed by different workers to various causes such as dry weather, wet soil, root trouble, poor soil conditions, poor soil fertility, lack of lime in the soil, climatic conditions, physiological conditions of plants, sun scald, etc. Yet, alfalfa "yellows" occurred on land on which all of these discernible causes had been corrected, and under various climatic conditions. It led to a suspicion that there must be some other cause not yet found.

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[1] Contribution from the Department of Economic Entomology, Wisconsin Agricultural Experiment Station.

C. V. Piper in 1914, in his book on "Forage Plants and Their Culture," suggested that "the disease is probably related to the mosaic of tobacco," and that "a species of leafhopper seems to be constantly associated with alfalfa yellows." Evidently his reference to leafhoppers was not favorably received by his co-workers, for in his new and revised edition of 1924, he refrains from mentioning the leafhoppers in his discussion of alfalfa "yellows," and refers to unfavorable soil conditions, lack of lime, plant food and drainage as evident causes of alfalfa "yellows."

Geo. A. Dean in 1916, while discussing various insects injurious to alfalfa, refers to several leafhoppers—especially to the clover leafhopper, *Agallia sanguinolenta* (Provancher), which is said to be "the most widely distributed in the alfalfa districts," and states that "the feeding punctures cause pale yellowish spots, and if very numerous give the foliage a distinct yellowish or bleached appearance." This is probably the first definite record made in entomological literature in regard to field observations with reference to leafhopper feeding injury to alfalfa plants, which resembles that which is known as alfalfa "yellows" or alfalfa "yellow top."

The relationship between leafhoppers and alfalfa "yellow top" was not determined by experimental methods, however, until recently. Several preliminary tests that have been conducted at the Wisconsin Agricultural Experiment Station,[2] definitely proved that such correlation exists.

During the summers of 1926 and 1927, especially in late June and through the months of July and August, alfalfa "yellows" was very common in Wisconsin. The second crop of alfalfa suffered the most. It was observed that the alfalfa discoloration usually began adjacent to the grassy land, along the edges of the fields, especially along weedy borders, such as ditches, road sides, fences, etc. These original yellow patches gradually spread farther into the fields and in several weeks time the entire alfalfa fields showed typical symptoms of alfalfa "yellow top" or "yellows."

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[2] Jones, F. R., and Granovsky, A. A. Yellowing of alfalfa caused by leafhoppers. (Abst.) Phytopath., *17*:39. 1927.

At the same time it was observed that several species of leafhoppers, especially *Empoasca fabae* (Harris), and *Deltocephalus inimicus* (Say) occurred in great abundance over the affected alfalfa fields. Such species as *Thamnotettix nigrifrons* (Forbes), *Eutettix seminudus* (Say) and *Cicadula sexnotata* (Fallen) were also present in the order given, but on the whole in negligible numbers.

The fields in which alfalfa retained its normal green color were found to be infested with leafhoppers to a much lower degree than those showing the typical symptoms. The infestation was determined by numerous sweepings with an insect net in alfalfa fields in different localities.

These observations in the fields with reference to the association of alfalfa yellowing with the presence of several species of leafhoppers were found to be constant. Since it has been shown that the curly-top of sugar beet is produced by punctures of the beet leafhopper, *Eutettix tenella* Baker; the aster yellows is transmitted by the aster leafhopper, *Cicadula sexnotata* (Fallen); the potato hopperburn is caused by the feeding of the potato leafhopper, *Empoasca fabae* (Harris), and the discoloration of apple leaves is caused by the same species, not mentioning the sugar cane mosaic and other virus diseases initiated by various species of leafhoppers,—it was of interest to determine experimentally whether any of the species commonly found in the alfalfa fields, were also responsible for alfalfa "yellows."

Preliminary infestation experiments were started July 7, 1926 with potted plants in the greenhouse. Healthy alfalfa plants grown in the greenhouse were placed in the insect proof cages, which then were infested with leafhoppers collected at random from affected alfalfa in the field. In seven days of feeding the typical symptoms were produced under greenhouse conditions. The intensity of the symptoms progressed rapidly during the next week, sufficient to indicate that leafhopper feeding is responsible for the discoloration of alfalfa foliage. Control plants remained healthy and retained their normal green color throughout the experiment.

Field experiments were started on July 26, 1926. Fourteen insect proof cages, with double compartments each, were constructed over several varieties of alfalfa in the field. The walls of the cages were placed deep in the ground to prevent accidental introduction of other insects. The alfalfa in the cages was cut back to the ground and the cages were thoroughly fumigated with calcium cyanide to destroy all insect life present therein. When new growth reached about four or five inches, one compartment of each cage was infested with leafhoppers and the other was left uninfested, free from insects, as a control. These cages were watched for symptoms at frequent intervals.

The initial symptoms were produced in one week of insect feeding after infestation, and a few days later the infested alfalfa showed characteristic yellowing and dwarfing entirely indistinguishable from that in surrounding fields, while in the uninfested cages the alfalfa was vigorous and green.

Similar experiments were performed in the field with some modifications and improvements until late in the fall of 1926, using a definite number of leafhoppers per plant, and exercising a greater care in the segregation of species of live leafhoppers before infestation of the cages.

During the winter months of 1926–27, work was carried on in the greenhouse with the potted plants several months old, using from one to ten leafhoppers per plant. In the summer of 1927 some additional observations and experiments were conducted in order to clear a number of puzzling questions, as well as to differentiate the symptoms produced by leafhoppers as compared with the yellowing caused by other factors.

These experiments under controlled conditions, both, in the green house and in the field, have demonstrated for the first time beyond a doubt that *Empoasca fabae* is responsible for this old trouble.

Perfectly healthy green plants in five or six days after infestation showed spotted mottling and blotches on the tender leaves. Two or three days later the spotted areas fused, producing a striated discoloration between the lateral veins of the apical leaves. Later this discoloration progressed until a considerable yellowing of the leaves was evident. At the end of the second week, the tops of the plants turned from a deep yellow to an orange yellow with bronzed edges of the leaves. Very often a peculiar purplish tinge of the tops was noticed. In case of severe injury the affected leaves shriveled and finally dried up.

Two weeks after infestation the plants appeared to be badly stunted. The new growth was very negligible on account of the marked shortening of the internodes, considerable rosetting and abundant prolification of the new short shoots in the axis of the leaves. These shoots were invariably dwarfed. The new leaves on the main stems and on the lateral shoots, produced after infestation, were about one-fourth the size of the leaves formed before the infestation or as compared with the normal control plants.

On account of considerable retardation of growth, general stunting and dwarfing, as well as the diminutive size of the leaves—the alfalfa "yellow top" is generally considered of great economic importance in alfalfa growing states. The infested fields of alfalfa as a rule yield only one-third of a normal crop of hay.

The older alfalfa plants are evidently more resistant to leafhopper feeding and symptoms appear gradually. The symptoms are much intensified by the prolongation of the time of leafhopper feeding or by the severity of the infestation. Five leafhoppers per one year old plant is sufficient to produce conspicuous symptoms in from one to two weeks of feeding. Ten nymphs of later instars in two weeks cause severe injury to a plant. In two or three weeks after a severe infestation many leaves not only turn yellow, but often curl upward, gradually turning brown, and finally shrivel and die.

The young alfalfa seedlings are always very badly stunted and are often killed outright in a few days by insect feeding. The leaves, petioles, and the upper portions of the succulent shoots of young seedlings withered and entirely collapsed in from 24 to 48 hours as a result of feeding of one leafhopper or its nymph per leaf.

The hairy Peruvian alfalfa is usually considered immune to the alfalfa "yellow top," but several tests showed that while it is not preferred by leafhoppers in the open fields, it is subject to identical symptoms as are the other varieties of alfalfa when leafhoppers in cages are concentrated on it.

In autumn the alfalfa crowns of healthy plants were large with prolific and sturdy crown buds. In the infested cages the crowns were conspicuously smaller with a very few, and very feeble crown buds as compared with those in the uninfested cages. The root system of the infested plants was found to be considerably weakened with almost completely collapsed aerial parts of the plants. Such condition of plants, with the weakened roots, caused by leafhoppers, is considered an important contributing factor in winter killing of alfalfa seedings, which is somewhat common in the State of Wisconsin.

Field observations and experiments indicate that not only alfalfa plants suffer from leafhopper feeding, which causes the diseased condition of the plants, but many other economic plants of the legume family such as clover, soybeans, garden beans, etc., are also seriously affected by leafhopper feeding, symptoms of which are puzzling and are often confused with mosaic diseases of these plants.

The nature of the alfalfa "yellow top" is not definitely known and it requires further experimentation. The symptoms, however, indicate the presence of some infective principle or virulent toxin introduced into the tissue of the plants with the salivary secretion in the process of insect feeding. Studies of certain phases of the problem toward the solution of this question are now in progress at the Wisconsin Experiment Station.

MR. ALBERT HARTZELL: I would like to ask whether there is any evidence that the disease is systemic.

MR. A. A. GRANOVSKY: It is not a systemic disease. The term yellows used for this disease is a misnomer. I prefer using the term yellow top for the reason that yellows has a distinct set of characters that go with the yellows diseases as understood by plant pathologists. It is not systemic, there is some movement although of the infective principle in the tissue, but it is relatively very short. It seems to me there is a toxic effect introduced by the insect which disorganizes the tissue.

I would like to mention that chemical tests show a very interesting story, but I would rather leave that for some future time.

MR. SMITH: In the illustration the affected leaves had dark spots. Does that represent feeding punctures?

MR. A. A. GRANOVSKY: No.

MR. SMITH: My reason for asking the question was that I did not notice it on the checks.

MR. HERBERT OSBORN: I haven't any particular question to ask, but I should like to say I want to compliment Mr. Granovsky for what appears to be a real contribution to the subject. A contribution like this is very well worth while.

MR. L. O. HOWARD: I happened to be sitting next to Mr. Granovsky yesterday morning, and he said he had heard from the other side about a trip I took over there last summer. His paper coming in just now is very significant. He has pointed out something that people did not know anything about before. The Minister of Agriculture of Poland in talking with me last summer, said, "In America there is use for your service. You have these great insect outbreaks, but over here the insects do comparatively little damage. We have a close system of cultivation. We have, as a rule, small holdings, and the insect problem is not serious with us."

Having Professor Osborn's work in Iowa on the leafhopper investigations in pastures in mind, I replied at once, "You don't realize how much damage the insects are doing to you. Take any one of your crops, and there are millions upon millions of little mouths, millions on millions of little beaks taking the nourishment from the plants. Try to find out just how much bigger crops you can raise if you were to eliminate these unnoticed enemies."

Don't you see how apt Mr. Granovsky's paper is in that respect and how important it would be for him to send his contribution to the Balkan countries?

From what country do you come?

MR. A. A. GRANOVSKY: Ukrania.

MR. L. O. HOWARD: You could send it to the neighboring countries, to all of your friends over there. I think you will succeed in emphasizing my point.

FIRST VICE-PRESIDENT W. P. FLINT: It might be of interest to some to know that we have been carrying on work in Illinois which Dr. Granovsky knows about, along much the same line, except that we have been working on clovers more than on alfalfa. One of the most interesting things that has come out of this work is the fact that the foreign clovers are killed by even what we would call a slight leafhopper infestation. The foreign clovers are, as a class, glabrous and the American clovers pubescent. Apparently the physical characters of the two classes of plants have a great deal to do with the effect of the leafhoppers.

We have some very striking results and there is little doubt that the leafhopper is one of the chief reasons why foreign clovers have been making such poor yields when planted in this country.

FIRST VICE-PRESIDENT W. P. FLINT: The next paper on the program is by J. H. Bigger.

HIBERNATION STUDIES OF *COLASPIS BRUNNEA* (FAB.)[1]

By J. H. BIGGER, *Illinois Natural History Survey*

ABSTRACT

During the years 1924–1926 the Grape Colaspis, *Colaspis brunnea* Fab., became a serious corn pest in the central part of Illinois. Investigations showed that the damage occurred mainly after clover was plowed under and corn planted as the succeeding crop. Corn on late-spring plowed red clover land was most severely damaged. The hibernation studies here reported are part of a project for the control of this insect. These studies show that the Grape Colaspis hibernates as a larva below the frost line in the clover fields. It is shown to be most numerous in second year red clover fields.

During the years 1924 to 1926 the Grape Colaspis, *Colaspis brunnea* (Fab.), developed into a serious pest of corn over the main corn belt area of Illinois. At first damage was rather limited in scope, but during the later years it became widespread. In 1926 at least 2,000 acres of corn was totally destroyed, and many more were damaged, by the feeding of the larvae on the roots of the corn seedlings.

DESCRIPTION OF INJURY: The damage by the larvae takes the form of feeding off the surface of the primary root of the young corn plant before it has produced many lateral, or feeding roots. This feeding not only damages the root itself but, when severe, removes enough of the root hairs to starve the plant. The loss of food and moisture causes wilting and, where the feeding is extensive, the death of the plant. There is a rather typical reddening of the leaves of the injured plants, most noticeable at first at the tips and along the veins.

PRELIMINARY OBSERVATIONS: During 1925 and 1926 examinations were made of many infested fields in western Illinois. These examinations tended to show, during 1925, that the greatest damage occurred where clover sod was plowed under and corn followed as the next crop. During 1926 a survey rather definitely determined that the most severe destruction of the corn crop followed after the plowing under of red clover or alsike clover, and not after plowing under sweet clover. Further examinations indicated that the damage was generally severe following late spring plowing and not after fall or early spring plowing. Damage occurred in some cases after other crops.

With this information on hand a study of the life and habits of the Grape Colaspis was undertaken and the information regarding hibernation was obtained in this connection.

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[1] Of Project 3.3 of the Entomological section of the Illinois Natural History Survey.

HIBERNATION STUDIES

As opportunity presented itself during the fall and early winter season of 1926 examinations were made about the roots of various plants, on the upper portions of which numbers of adults of *C. brunnea* had been observed during the summer, to determine in what form these insects passed the winter. During the latter part of October larvae were found just below the surface of the soil around the roots of red clover. Whether they stayed in the same place all winter then became the question, and further examinations became necessary. Tentative diggings of plants were made Oct. 25th and 27th, 1926. These showed numbers of larvae around the roots at not more than 2 inches deep. Diggings made Nov. 5, 1926 showed larvae about 6 inches below the surface. This suggested a possible migration from the surface to the lower depths in the soil, and a series of diggings was started.

METHOD OF EXAMINATIONS: In making diggings for these larvae a cubic foot of soil, a foot square at the surface, was removed in each case except where otherwise noted. At first this amount was entirely removed in 2 inch layers, later the upper 6 inches was removed as one layer and in all the tabulated material included here the earlier diggings have been converted to correspond with the later ones. Diggings were made in fields that were the first and second year in red clover, the first and second year in sweet clover, and in timothy and soybeans. The results of the diggings are shown in the various tables following.

All diggings were made in Morgan County, Illinois, and field numbers refer to a marked map in our files of this project.

SECOND YEAR RED CLOVER: Table 1. These examinations were made in second year growth of red clover that was ready to plow under for the next year's crop of corn. This was the first habitat established and here the most complete set of figures was obtained. Diggings extended from the first tentative ones Oct. 27, 1926 to those made Dec. 2, 1926. At the time when systematic diggings started the majorty of the larvae were in the 6–8 inch zone. From that time until the end of November a decided migration to the lower, or 8–10 inch zone, is shown by a decrease in per cent of larvae in the first and increase in the per cent of larvae in the second. A few of the larvae moved to the 10–12 inch zone, but the greatest numbers were constantly found during the later diggings in the 8–10 inch area. Several diggings were extended below 12 inches, but no larvae were found there at any time.

FIRST YEAR RED CLOVER: Table 2. From the conditions found in the above habitat it was thought advisable to extend operations, so

TABLE 1. DEPTH AT WHICH LARVAE OF *Colaspis brunnea* WERE FOUND AT DIFFERENT DATES IN SECOND YEAR RED CLOVER

Date	Field Number	Number Larvae	Number 1–6 in. deep	Per cent 1–6 in. deep	Number 6–8 in. deep	Per cent 6–8 in. deep	Number 8–10 in. deep	Per cent 8–10 in. deep	Number 10–12 in. deep	Per cent 10–12 in. deep
10/27/26	1	Several	All	100.0						
11/5/26	1	57	6	10.5	42	73.7	8	14.0	1	1.7
11/6/26	1	67	9	13.4	46	68.6	7	10.4	5	7.4
11/12/26	1	51	3	5.8	26	50.9	20	39.2	2	3.9
11/23/26	1	34	5	14.7	7	20.6	21	61.7	1	2.9
11/26/26	2	16	3	18.7	4	25.0	9	56.2	0	—
12/2/26	2	19	1	5.2	7	36.8	11	57.7	0	—
12/2/26	2	20	0	——	9	45.0	10	50.0	1	5.0

TABLE 2. DEPTH AT WHICH LARVAE OF *Colaspis brunnea* WERE FOUND AT DIFFERENT DATES IN FIRST YEAR RED CLOVER

Date	Field Number	Number Larvae	Number 1–6 in. deep	Per cent 1–6 in. deep	Number 6–8 in. deep	Per cent 6–8 in. deep	Number 8–10 in. deep	Per cent 8–10 in. deep	Number 10–12 in. deep	Per cent 10–12 in. deep
10/25/26	3	0	—	No deeper diggings made at this time.						
11/27/26	3	0	—	—	—	—	—	—	—	—
11/27/26	3	0	—	—	—	—	—	—	—	—
11/29/26	4	2	2	100.0	0	—	—	—	—	—
12/1/26	4	2	1	50.0	0	—	1	50.0	—	—
12/1/26	4	0	—	—	—	—	—	—	—	—

examinations were started in fields that were passing their first year in red clover.

So few larvae were found that no definite conclusions can be arrived at from this material, but the data are included as a comparison with Table 1.

SWEET CLOVER: Table 3 and Table 4. In order to have as nearly a complete set of figures as possible and to obtain some evidence as to the causes of conditions observed in corn fields following sweet clover, as well as following red clover, some diggings were made in sweet clover fields late in the season.

These were not started soon enough to show any migration but bear out the observations made in the red clover in so far as they show the presence of the greater part of the larvae below the frost line.

In sweet clover fields the larvae evidently do not go so deep as in red clover fields. The frost line in red clover fields was determined by examinations Jan. 29, 1927 to be from 5½ to 6½ inches deep. Diggings made in both sweet clover and red clover fields Dec. 23, 1927 showed that the ground was not frozen so deeply in sweet clover fields with normal ground cover as in red clover fields.

SOYBEANS: Eight examinations ranging from Nov. 1, 1926 to Dec. 10, 1926 were made in three fields where soybeans had been grown during the previous season. These gave a net return of only one larva of *C. brunnea*. The first examination consisted of digging spade-deep along 25 feet of drill row. The other seven examinations were cubic foot areas as previously described. Tentative diggings were made in three other fields; no larvae were found and no regular diggings made.

TIMOTHY: Examinations in cubic foot areas of timothy sod were made in five places in two fields on Dec. 11, 1926 and Dec. 13, 1926. In three of the diggings, two in one field and one in another, a total of four larvae were found. One of these was in the surface 1–6 inch area, two in the 6–8 inch area, and one in the 8–10 inch area.

NUMBERS IN DIFFERENT HABITATS: An interesting comparison of the numbers of larvae in the soil around the roots of the various crops appears in our figures. Our counts are not yet numerous enough to draw definite conclusions.

Second year red clover growth has more larvae than any other crop. Sweet clover has comparatively few, and the other crops few. The figures shown here correspond very well with notes of damage to corn by larvae where it appeared that corn after second year red clover suffered the most severe damage.

TABLE 3. DEPTH AT WHICH LARVAE OF *Colaspis brunnea* WERE FOUND HIBERNATING IN SECOND YEAR SWEET CLOVER

Date	Field Number	Number Larvae	Number 1–6 in. deep	Per cent 1–6 in. deep	Number 6–8 in. deep	Per cent 6–8 in. deep	Number 8–10 in. deep	Per cent 8–10 in. deep	Number 10–12 in. deep	Per cent 10–12 in. deep
12/3/26	5	6	1	16.6	4	66.6	1	16.6	0	—
12/3/26	5	5	2	40.0	2	40.0	1	20.0	0	—
12/4/26	8	15	2	13.3	10	66.6	3	20.0	0	—
12/4/26	8	16	2	12.5	11	68.7	2	12.5	1	6.2

TABLE 4. DEPTH AT WHICH LARVAE OF *Colaspis brunnea* WERE FOUND HIBERNATING IN FIRST YEAR SWEET CLOVER

Date	Field Number	Number Larvae	Number 1–6 in. deep	Per cent 1–6 in. deep	Number 6–8 in. deep	Per cent 6–8 in. deep	Number 8–10 in. deep	Per cent 8–10 in. deep	Number 10–12 in. deep	Per cent 10–12 in. deep
12/3/26	6	4	0	—	3	75.0	1	25.0	0	—
12/3/26	6	6	2	33.3	2	33.3	1	16.6	1	16.6
12/3/26	6	6	2	33.3	2	33.3	1	16.6	1	16.6

TABLE 5. NUMBERS OF LARVAE OF *Colaspis brunnea* IN SOIL AT ROOTS OF VARIOUS CROPS

Crop	Number Diggings	Number Fields	Number Larvae Found	Number Larvae per cu. ft.	Maximum	Minimum
2nd year red clover.......	8	2	264	33.0	67	16
1st year red clover........	6	2	4	.66	2	2
2nd year sweet clover.....	4	2	42	10.5	16	5
1st year sweet clover......	3	2	16	5.33	6	4
Soybeans................	8	3	1	.12	1	0
Timothy................	5	2	4	.8	2	0

CONCLUSIONS: *Colaspis brunnea* passes the winter in the larval state. The greater majority of larvae go below the line of heaviest frost in the fields. In red clover the largest numbers are found 8–10 inches below the surface. In sweet clover the largest numbers are found 6–8 inches below the surface.

The largest numbers of larvae were uniformly found in the soil around the roots of second year red clover. Few were found in first year red clover, few in sweet clover, and very few in soybean and timothy fields.

The material here presented was gathered in the course of studies made under a project of the Illinois Natural History Survey to develop a method of preventing damage by *C. brunnea* to corn.

Note: Studies made in 1927 and not yet compiled will support the conclusions here arrived at.

FIRST VICE-PRESIDENT W. P. FLINT: The next paper is by Herbert Spencer and W. E. Hinds.

UTILIZATION OF *TRICHOGRAMMA MINUTUM* FOR CONTROL OF THE SUGARCANE BORER

By W. E. HINDS and HERBERT SPENCER, *Louisiana Experiment Station*

ABSTRACT

The value of *Trichogramma minutum* for control of sugarcane borer has been studied in the field since September, 1925, and under Louisiana conditions has been found to be the most effective natural control factor, especially during August, September, October and November.

A method for laboratory production and increase has been devised, and in June and July 1927 a small scale colonization experiment was apparently successful. Details of rearing technique and plans for 1928 work on a larger scale are discussed.

Trichogramma minutum Riley is a very small Hymenopterous parasite which attacks the eggs of more than fifty species of Lepidoptera, including the Sugarcane Borer (*Diatraea saccharalis* Fab.), the European Corn Borer (*Pyrausta nubilalis* Hbn.), Codling Moth (*Carpocapsa pomonella* L.), Potato Tuber Worm (*Phthorimaea operculella* Zell.), Tobacco and Tomato Hornworms (*Protoparce* spp.), Corn Ear Worm (*Heliothis obsoleta* Fab.), Angoumois and other grain moths (*Sitotroga cerealella* Ol. and *Plodia interpunctella* Hb.); several species of Hymenoptera, mostly sawflies; and at least two Coleoptera (*Metriona bicolor* Fab. and *Metriona signifera* Herbst.[1])

FIELD OBSERVATIONS ON TRICHOGRAMMA. In all of the host species observed, the eggs that are parasitized become black before emergence of the adults, and the shells remain black after emergence (Plate 5, Figure 7). For this reason it is relatively easy to examine eggs collected in the field, and to determine the efficiency of the parasite in that part of the growing season by the percentage of eggs destroyed by parasites. Since September 1925 egg collections and examinations have been made for this purpose, and the indications are that the Trichogramma parasites are few in number each spring, increase slowly until late July, but after that time become very numerous and very effective in reducing the numbers of sugarcane borers. The results for 1927 are representative and are given in summary in Table 1:

TABLE 1. SUGARCANE BORER: NATURAL EGG PARASITISM BY TRICHOGRAMMA, LOUISIANA, 1927

	Egg Brood	Eggs Examined	Per cent Parasitized
March–April	I	750	2.6[1]
May–June	II	2,899	23.9
July	III	31,732	10.4
Aug.–Sept.–Oct.	IV, V, VI	92,874	88.6

[1] Only one parasitized batch of eggs found in this group.

There are several factors concerned in the apparent inefficiency of the parasite in the spring and early summer, including temperature, scarcity of host eggs, discontinuity of host egg broods, and location of hibernating areas, but the matter of parasite distribution is of especial significance:

Even as late as July 12, there were fields of corn and cane in which no parasites could be found; also, the percentage of parasitism varied from zero to more than 51 per cent in different fields of corn and cane between June 20 and July 15, 1927. Earlier in the season parasites were present in smaller numbers, and in fewer fields of cane and corn, although unparasitized eggs were found in moderate numbers. In tomato fields each year the parasite appeared early, and a high percentage (64% in 1927) of the eggs of Tomato Hornworm (*Protoparce sexta* John.) were affected. Out of the parasitized hornworm eggs were reared an average of 22 adult parasites per egg.

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[1] Reared from *Metronia spp.* eggs at Baton Rouge, La., July 20 and August 2, 1922 by C. E. Smith.

Such a great variation in the percentages of parasitism in different fields under approximately the same cultural and climatic conditions led us to believe that Trichogramma spreads very slowly from field to field in the spring, possibly on account of its delicate weak nature and poor flying ability.

TABLE 2. PERCENTAGES OF PARASITISM BY TRICHOGRAMMA IN FIELDS, JUNE 20 TO JULY 15, 1927

Date	Crop	Eggs Collected	Eggs Parasitized	Per cent Parasitism
6/20	Cane	273	15	5.4
6/20	Cane	356	87	24.4
6/22	Cane	3,039	711	23.4
6/22	Cane	487	112	23.0
6/28	Cane	1,656	15	0.9
6/29	Cane	256	28	10.9
6/29	Corn	302	67	22.1
6/29	Corn	1,094	562	51.4
7/1	Tomatoes	145[1]	94	64.8
7/6	Cane	427	0	0
7/7	Corn	455	57	12.5
7/8	Corn	1,714	103	6.0
7/11	Cane	889	125	14.0
7/12	Corn	691	0	0
7/13	Corn	1,450	10	0.7
7/14	Corn	425	59	13.8
7/15	Cane	910	91	10.0

[1] *Protoparce* eggs; all other records from *Diatraea* eggs.

PRELIMINARY COLONIZATION EXPERIMENT. A consideration of this data and hypothesis led to the hope that artificial colonization of Trichogramma into fields from which it was absent early in the spring might establish the parasites and start them to work earlier than if natural spread was depended upon alone. So in June and July 1927 a small scale Trichogramma colonization experiment was carried out on a cane plantation at Cinclare, Louisiana. Two similar fields of cane were located within one-half mile of each other, both without any Trichogramma parasitism. Beginning June 9, parasitized eggs reared in the laboratory, just ready to emerge as adult Trichogrammas, were placed in one of these cane fields, in the following approximate numbers: June 9, 13,000; June 15, 16,000; June 18, 14,000; June 22, 13,000; June 24, 10,000; June 28, 16,000; and July 14, 12,000. In all, about 94,000 parasitized eggs were placed in the colonized field. To determine the results of this work, collections of eggs were made and the percentage of parasitism determined:

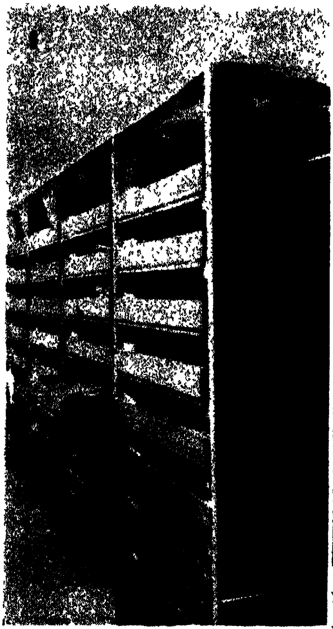
TABLE 3. TRICHOGRAMMA COLONIZATION EXPERIMENT, CINCLARE, LOUISIANA, 1927

	Percentages of Egg Parasitism	
	Colonized Field[1]	Check Field
June 9	0	0
June 23	2.4	0
July 6	6.9	1.4
July 16	16.4	9.9
Sept. 20	97.7	—

[1] 94,000 parasites liberated in field between June 9 and July 14. 18,562 eggs examined for above records.

In the colonization experiment, parasites were recovered from the colonized field two weeks after the first introduction. Unfortunately for the experiment they spread to the check field in another two weeks but throughout the season the percentage of parasitism was considerably lower in the check than in the colonized field. In the latter a peak of 97.7% efficiency was reached on September 20.

ARTIFICIAL REARING OF TRICHOGRAMMA. Artificial rearing of Trichogramma was started March 9, 1927 in the Louisiana Experiment Station Laboratory. Adult Angoumois Grain Moths (*Sitotroga cerealella* Ol.) were collected from corn cribs with vials and placed in quart square glass-topped mason jars, using a funnel arrangement for preventing escape during collection. For egg deposition, two sheets of three-inch filter paper were clamped under the glass cover. The inner sheet was punched with many holes one-eighth inch in diameter, and most of the eggs were laid through the holes and between the two papers. These papers were removed each day, separated, and with the eggs attached were exposed to parasites bred from cane-borer eggs from cane fields, using petri dishes as containers. With a brood of parasites maturing in ten days in the laboratory, with considerable increase in numbers, laboratory produced parasites were soon used in the petri dishes, and by June a surplus of parasites was on hand, sufficient for the colonization work discussed, and for another similar experiment performed at Baton Rouge.



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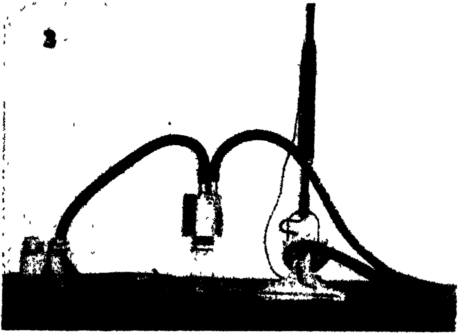
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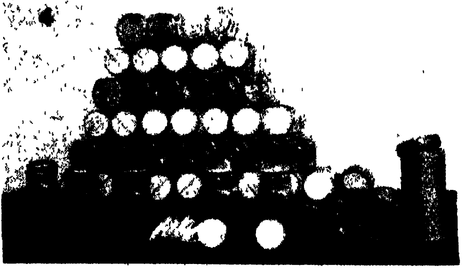

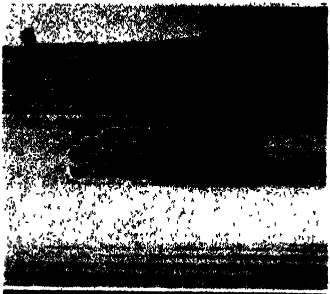

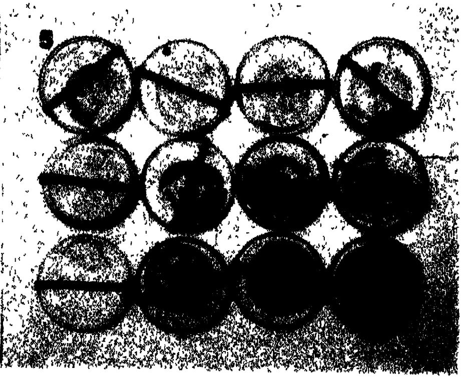

EQUIPMENT FOR QUANTITY PRODUCTION IN 1928. The results of the 1927 work with Trichogramma were encouraging enough to induce us to plan more extensive colonization and control experiments for 1928. In order to have sufficient parasites for the proposed work, equipment with much greater capacity has been devised and constructed. For rearing Angoumois Grain Moths two rooms have been constructed (Plate—, Figure 1), each 12 feet by 16 feet with ceiling seven feet high. The walls and ceiling are insulated with double layers of "Celotex" wall-board, and are plastered smoothly inside. In the center of each room is a rack holding tiers of removable trays, each tray with a capacity of approximately one bushel of corn. The corn, 125 bushels in all, was fumigated to rid it of all weevils, and many thousands of eggs of *Sitotroga* were placed back, to develop a "pure" breeding stock. The temperature is held between 75° and 85°F. by electric heating units and fans, the former controlled by simple bimetallic thermostats (Plate 5, Figure 2). In these rooms the development of Sitotroga is completed in from 30 to 35 days, but by adding eggs each day for the first month, a constant supply of moths was assured. After emerging, part of the adult moths stay in the corn trays, and part fly out to the smoothly plastered walls, where they are captured by a vacuum collector.

The vacuum collector (Plate 5, Figure 3), consists of an ordinary electric vacuum sweeper, provided with a hose outlet, which leads to a tin air chamber, made with an inner cylinder of fly screen, open at the lower end and fitting the mouth of a square quart mason jar. From the middle of the top of the inner screen cylinder another hose leads to the aluminum sweeper attachment, with which the moths are drawn from the walls of the room. In operation the air is drawn through the inner screen cylinder, but the moths cannot pass through the meshes to the sweeper, and so drop into the mason jar. With our sweeper it was necessary to bore holes in the outer air chamber to lessen the suction,

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PLATE 5. REARING TRICHOGRAMMA FOR COLONIZATION EXPERIMENTS

Figure 1. Room with rack of trays for corn used in rearing *Sitotroga cerealella* moths.

Figure 2. Temperature control unit for moth rooms, including fan, thermoregulator, baffle plate and radiant electric heating elements.

Figure 3. Moth collector.

Figure 4. Egg laying (Mason) jars for moths.

Figure 5. Petri dishes containing *Trichogramma* adults and circles of paper with *Sitotroga* eggs affixed; for parasite egg deposition.

Figure 6. Normal *Diatraea saccharalis* eggs ready to hatch; from field.

Figure 7. Egg mass of *Diatraea*, with part of eggs hatched and remainder (black) parasitized by *Trichogramma*.

to keep from damaging the adult moths. Two or three hundred moths are placed in each mason jar and the covers are clamped on over a sheet of three inch white filter paper (Plate 5, Figure 4).

After 24 hours at room temperature or at 80°F. the jars are opened, a screen is placed over the mouth, and by inversion and shaking the eggs are screened on to a pane of glass, where they are cleaned and concentrated. Circles of cardboard are spread thinly with photo paste (We use "Cico") and with a brush the eggs are lifted and scattered over the circle. Each jar of moths yields two lots of eggs.

After drying, these "egg sheets" are placed in cold storage at 40°F. or are used at once, in petri dishes containing parasites or segments of previously exposed egg sheets from which the parasites are ready to emerge (Plate 5, Figure 5).

ACKNOWLEDGMENTS. In this work the authors have received help from several sources, and wish to express their indebtedness to Mr. Stanley E. Flanders, Saticoy, California, who is doing similar work and has cooperated in many ways; to Mr. C. E. Smith of Louisiana for new records of *Trichogramma* in eggs of *Metriona;* to Mr. B. A. Osterberger and Mr. C. L. Stracener of the Department Staff, for field work and construction of apparatus, and to Mr. C. O. Hopkins, for the extensive laboratory egg-counts and for routine production work carried on for many months.

MR. L. O. HOWARD: I promise not to discuss anything else. I don't want to talk too much, but it is most interesting to find that attention is being centered on Trichogramma in so many places just now. It is evidently a very promising species. It seems to be one of the first parasites that we are going to be able practically to domesticate. The European form has been studied at Berlin for two years and Marchal has been studying it intensively in Paris for more than a year. Flanders is doing wonderful work in California and Dr. Spencer and Dr. Hinds are working with the same genus in Louisiana. It is extremely interesting. It is a most adaptable species. It has many hosts and is adaptable in its biology. Marchal has found it accomodates itself in a most extraordinary way as to the number of generations, according to the host it parasitizes.

They have practically decided in Europe that the Trichogramma that have been described under very many specific names and several genera are all the same form. I am going to suggest to Dr. Spencer and Dr. Hinds that they send specimens to Dr. Paul Marchal in Paris and Dr.

Hase in Berlin. I think their comparative findings extremely interesting. Hase is interested in biological points about the variation of this species. I look forward to the work on Trichogramma with great confidence as eventually showing something very practical.

First Vice-President W. P. Flint: The next paper this morning is by K. M. King.

BARATHRA CONFIGURATA WLK., AN ARMYWORM WITH IMPORTANT POTENTIALITIES ON THE NORTHERN PRAIRIES[1]

By Kenneth M. King,[2] *Dominion Entomological Laboratory, Saksatoon, Sask.*

ABSTRACT

This paper deals chiefly with the life-history, economic importance and means of distinguishing the immature stages of this increasingly destructive native pest of flax, sweet clover, alfalfa, sugar beets, cabbage, corn and other plants.

The outbreak of 1927 in the Prairie Provinces was the climax, up to the present, of injury by *Barathra* (*Mamestra*) *configurata* (Walker 1856), a native Phalaenid (Noctuid) which has caused "commercial" damage in Saskatchewan each year since 1921, although observed as a crop pest only within the last 12 or 15 years. These records assume particular significance in view of the fact that *B. brassicae* L. has long been an important pest of cabbage, beets and allied crops, over wide areas of Europe and Asia (vide Valch '13).

In Eastern Canada, *B. curialis* Sm., the only other North American representative at present placed in this genus, occurred in outbreak numbers in 1905 (1, 2, 3, 4), and again in 1925 (7),[3] but is normally scarce or even rare (3) and personal communication from A. Gibson, and has never shown recurring abundance year after year as recorded for the western species. Although the larvae of *B. curialis* (3) are very similar in appearance to those of *B. configurata*, the moths of the two species are easily separated on wing markings, and Dr. J. McDunnough states that the male genitalia show distinct differences of specific value.

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[1] Contribution from the Division of Field Crop and Garden Insects, Entomological Branch, Department of Agriculture for Canada.

[2] The writer wishes to acknowledge his very considerable indebtedness to H. L. Seamans for the various records relating to Alberta, and to Norman Criddle for notes on the less extensive occurrence in Manitoba.

[3] In several of these papers (1, 2, 4, 7), *B. curialis* is referred to in error (vide 3) under the name of *B. occidentata* Grt. a synonym of *B. configurata*.

Ecologically, the two are almost equally distinct, *curialis* occurring almost invariably in forested districts, chiefly northwestern, while *configurata* is typically associated with grassland areas. The larval food plants and feeding habits show some important diversities, though very similar in the main, and the pupae exhibit slight morphological differences when a series is considered.

COMMON NAME. The economic importance of *B. configurata* already is sufficiently widespread to call for the official adoption of a common name for it. The name Bertha armyworm was strongly recommended, after thorough discussion during the 1927 sessions at Saskatoon, by the International Great Plains Crop Pest Committee, an organization of entomologists representative of the entire area in which the species is at present known to have any economic standing.

This recommendation was based on the following considerations:—(1) The name, which was originated by the farmers affected by the pest, already has considerable standing among them; (2) a common name based upon the injury to any one plant or a single plant part is inappropriate in popular usage, in view of the variety of food plants and of the parts attacked; (3) likewise the use of a variety of common names for it seems inadvisable; (4) under the circumstances, by far the best alternative would appear to be the adoption of a concise name easily adapted to popular usage, even though the name may not in itself be significant; (5) ample precedent for this may be found, both in entomology and in the official common names in other animal groups; (6) *B. configurata* has been observed on rather numerous occasions, when very abundant, migrating slowly, but in a definitely armyworm fashion.

PLANTS ATTACKED AND EXTENT OF INJURY. The larvae of this species attack rather freely nearly every dicotyledonous plant[4] growing in flower and vegetable gardens and in cultivated fields. In common with other species of the genus, members of the families Chenopodiaceae and Brassicaceae (Cruciferae) are more or less favoured food plants. The severe injury to flax, sweet clover and alfalfa is recorded however only for *B. configurata*. The more mature larvae typically feed upon the ripening seed pods, if available, but flowers and leaves are also readily eaten.

The work on flax (Plate 6-5) seems that most characteristic of the species, since similar injury by any other cutworm has not been observed. In this locality the *Barathra* larvae usually approach maturity at about the same time as the flax, and the most serious attack is on the greener seed pods, which are eaten entire, leaving only the bracts or a portion of the carpels. As the pods mature, the worms bore into them from the side, eating out the contents, something after the fashion of the boll-worm on cotton. Earlier in the season, the flowers and leaves are heavily attacked. In one reported instance, the flax seed-crop in a large field was reduced on an average not less than one-half. In large areas of another field, 75 per cent of the bolls were destroyed. Losses of 15 to 30 per cent in a field have been observed rather frequently.

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[4] The actual records are:—(garden flowers) Delphinium or larkspur, marigold, sweet pea, poppy, petunia, hollyhock, sunflower, zinnia; (wild flowers) wild rose, gumweed, wild sunflower, wild flax? native larkspur?; (garden and truck crops) cabbage, beets, sweet corn, tomato, cauliflower, swiss chard, garden pea and bean, broad bean, lettuce, turnip, rhubarb, potatoes; (field crops) flax, sweet clover, alfalfa, red clover, sugar beet, mangels, corn, field peas, sunflower, wheat; (weeds) lamb's quarter, redroot pigweed, Russian pigweed, Russian thistle, various wild mustards.

The ravages to sweet clover and alfalfa grown for seed are sometimes even more severe (Plate 6–3). In one instance, a two hundred acre field of sweet clover was so badly damaged that no attempt was made to harvest the small amount of seed remaining. In 1927, in Alberta, destruction of more than 1500 acres of seed crop was reported. In one ruined field, H. L. Seamans estimated that the infestation at the height of the damage ran as high as 200 worms or more to the square foot of area; after a rather high proportion had moved off to other fields, 146 pupae were found in one square yard. Seed injury reaches its maximum in sweet clover fields of several years standing. The hay crop is often appreciably reduced, but to what extent it is difficult to estimate. Seedling alfalfa and sweet clover are sometimes seriously damaged.

In common with other members of the genus, *Barathra configurata* attacks cabbage freely. In the vicinity of Saskatoon, it has been the most serious enemy of this crop in many fields and gardens within recent years. In 1925, in one small field, 60 per cent of 1,200 plants were rendered unfit for human consumption, by the work of this species, neither *Plutella maculipennis* Curt. nor *Pieris* spp. (*P. rapae* L. and *P. occidentalis* Reck.) being common in the field. In 1927, a nearly mature head, which bore no outward evidence of heavier infestation than the others of the field, was found to contain 18 *Barathra* larvae, while two more were in the soil at the base of this plant; early cabbage here was severely injured, while late or "winter" varieties were scarcely touched.

The injury to ears of corn (Plate 6–4) rather closely resembles that by the corn earworm (*Heliothis obsoleta* Fab.), but is usually less severe, inasmuch as the *Barathra* larvae frequently do not attack the sweet corn until fertilization is complete, and the work is then often confined to the silk. Rather important damage by it has been recorded, however.

The cutworms bore into the pods of peas and beans, and into tomato fruits, often causing appreciable losses. On a few occasions, sugar beets have been rather heavily attacked in Alberta.

A very unusual, but evidently authentic, record of injury to wheat, in 1927, was received from a correspondent, N. J. McLeod, Kelfield, Sask. The *Barathra* larvae had evidently been feeding on lamb's quarters in the wheat field, but when the weeds were completely eaten out by the passage through the field of an army of beet webworms (*Loxostege sticticalis* L.), many turned their attention to the only remaining plants at hand, and bored into the heads of wheat, actually eating out the kernels.

Some of the weeds, particularly lamb's quarters (*Chenopodium album* L.), are so suitable for oviposition and so heavily attacked by the larvae, as to be very important immediate sources of infestation to crops, as well as a means of multiplication, through successive seasons, to outbreak conditions.

DESCRIPTION OF STAGES[5]

Both adults and pupae (Fig. 19, 20) of the genus *Barathra* are well characterized structurally, but the larvae are not so easily distinguished, though their variability in itself is often suggestive when several of the colour forms occur together.

The colouration of the larvae of *B. configurata* agrees very well, in the main, with the excellent detailed description given by Fletcher and Gibson ('06) for *B. curialis*, but the last stage of the former is even more variable. During the first four instars the larvae have the appearance and often the habit of loopers (*Autographa*); the body is green in general colour, with more or less distinct, narrow, whitish, dorsal and subdorsal stripes, and a broader but indistinct substigmatal band. The larvae of the fifth stadium show changes grading towards the variable final instar; the majority are of the green type described, but others are brownish green, or brownish, with some blackish marks.

In the final larval stage, a black, conspicuously striped form (Plate 6–2), and a contrasting, almost unstriped, brownish form with black markings (Plate 6–1) are particularly common, but there are many other variants among individuals. Furthermore, rather marked differences often occur between groups in situations of different degrees of exposure, and ocassionally between those in similar situations but on different food plants. Encountered singly or in rather homogeneous groups, such as are frequently found in nature, many of these types would appear to represent distinct species, a fact which adds to the difficulties of accurate identification.

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[5] The present partial descriptions are primarily for purposes of differentiation.

Last stage larvae of *configurata* found in fully exposed situations, particularly when feeding on flax, are usually of dark shades, the pale gray or drab ground-colour being heavily overlaid with blackish (Plate 6–2); typically the narrow dorsal and subdorsal stripes of bright yellow are distinct and nearly continuous; the broad substigmatal band, which is very conspicuous because limited below and especially above by the dark areas, is pale yellow much flushed with red, the latter a distinctive feature; the black colouration may be more or less uniformly distributed over the dorsum, as in the darker forms, or there may be velvety black patches both above the spiracles and forming dorsal oblique bands or distinct W-marks in the dorsal region; a few specimens are almost solidly dull black above the spiracles, the yellow stripes being almost obliterated. Some larvae, including a fair proportion of those feeding on sweet clover and a large share of those in cabbage, are brown instead of blackish, often of a ruddy hue; in these, the dorsal velvety black patches or obliques are usually conspicuous (Plate 6–1). The substigmatal band which is so conspicuous in the dark forms, is indistinct or completely absent in these and the lighter kinds. The colouration of larvae, which are feeding completely hidden, in cabbage heads or ears of corn, often has a faded appearance. A few last instar larvae, especially those feeding on corn, retain the nearly uniform greenish colour of the early stages, while a few are distinctly and rather brightly yellow, with a few small blackish spots on the dorsum. The venter of all types is pale, usually greenish. The head is honey-yellow, coarsely mottled with dark brown. The average head width is 3.2 mm. (3.04 to 3.35). The mandibles are heavy and thick, fairly broad, tipped with black, with four large prominent teeth (the upper and lower sometimes slightly divided into two toothlets); on the inner face is a large, triangular, heavy, black, toothlike projection. The epicranial index (vide Ripley '23) is variable, the average (of 10) being 1.23, the minimum 0.90 and the maximum, 1.77. The crochet formula (full-grown larvae) is 21, 22, 25, 26, 29. The cuticle is smooth, without granules or spinules.

The pupa (Fig. 19, 20) is of the usual type of the Hadeninae as characterized by Mosher ('16). It is rather slender (5.5x18.5 mm.) gradually tapering caudally. The cremaster and spines (Fig.20) are very distinctive; the former is clearly differentiated, conical, dark, and rather strongly rugose; the comparatively stout terminal spines, 0.7 mm. long, are very close set and closely appressed, slightly divergent, straight except sometimes slightly outcurved at the tip, which is usually expanded into a button. The anterior third of the movable abdominal segments (5, 6 and 7) have a band of rather shallow punctures which are somewhat larger and deeper dorsally; there are also a few light punctures on the dorsum of the anterior abdominal segments, especially the fourth. The tips of the maxillae reach the posterior margin of the wings, are slightly expanded just before the tip, and considerably exceed the tips of the mesothoracic legs. The latter, which do not reach anteriorly to the eye pieces, usually are slightly shorter caudally than the antennae. Only very small portions of the metathoracic legs are visible, and do not touch medially. The spiracles are normal; the epicranial suture wanting.

According to Hampson ('05), the imagines of *Barathra* Hübner are characterized, among all other North American hairy-eyed Noctuids, by the presence of a long,

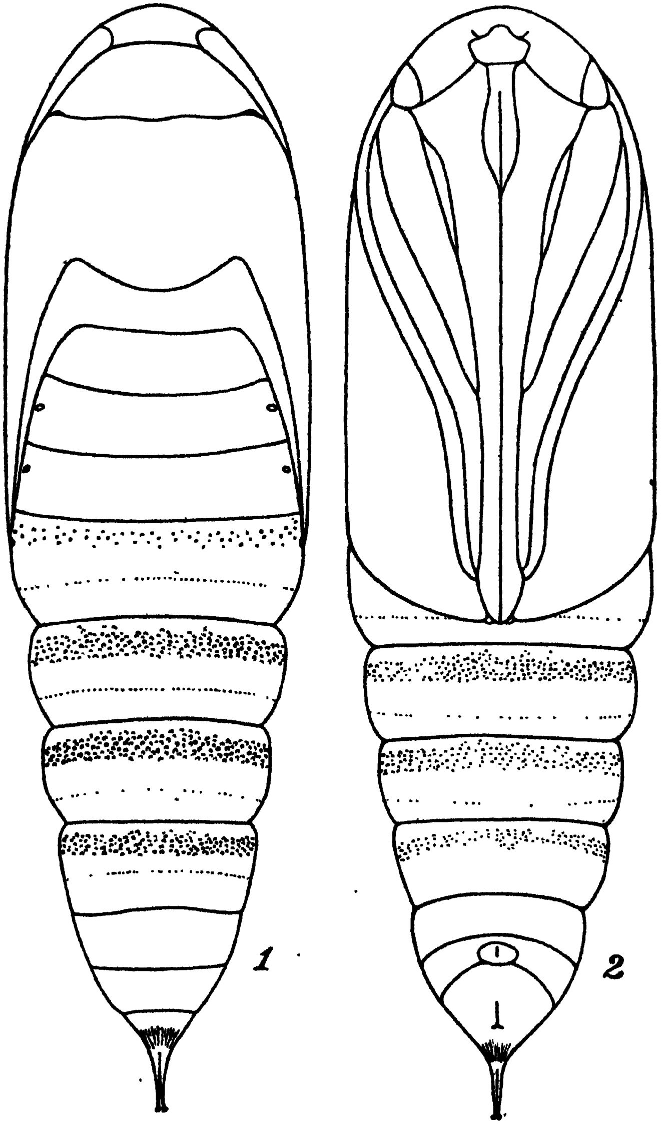

Fig. 19.—Pupal characters of *Barathra configurata*. 1, dorsal view; 2, ventral view; Original.

heavy, curved, terminal claw on the outer side of each fore tibia. The species *configurata* Walker is distinguished by the broad olive band just anterior to the subterminal line, which is prominently defined by whitish on the inner side. The moths are large, with a wing expanse of about one and one-half inches.

The egg is of the usual cutworm type, with about 38 ribs.

LIFE-HISTORY AND HABITS. The moths from the overwintering pupae begin to appear early in June and are sometimes present until August, the maximum abundance, in the average year in the northern prairies, being reached late in June or the early part of July. They feed freely upon flowers of various kinds, being found in the field particularly on those of wild mustards. They appear to be entirely nocturnal in habit. It has been repeatedly observed in the field that only occasionally are the moths attracted to light and this when a fairly bright light is very close to them. This, in part, explains the comparative rarity of the species in collections, and also the fact that even when the moths are known to be fairly abundant the light-trap catch is very small.[6]

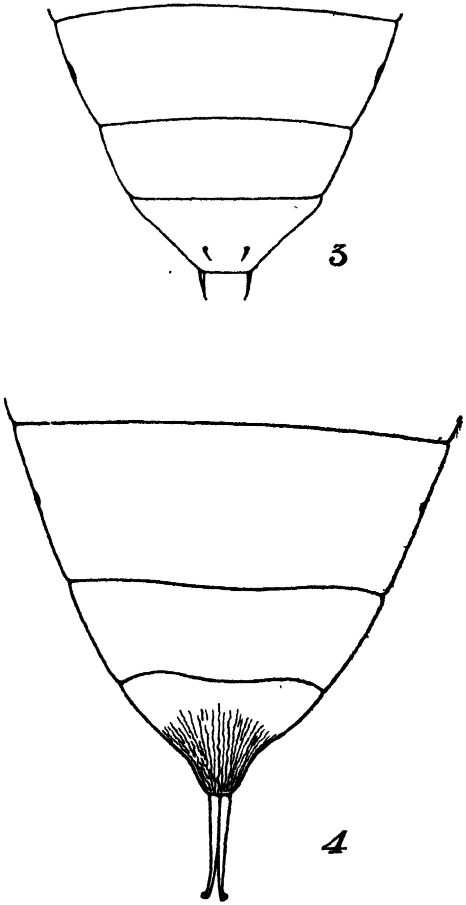

Fig. 20.—Pupal characters; 3, *Scotogramma trifolii*, caudal segments, dorsal view. 4, *Barathra configurata*, caudal segments, dorsal view, showing characteristic spines and rugose cremaster. Original.

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[6] The exception to this in the instance of the Lethbridge, Alberta light trap may be connected with the position of the light in very close proximity to flowering clematis.

After a fairly short pre-oviposition period, egg deposition begins. The eggs are laid in large flat patches upon vegetation. One mass discovered upon a leaf of lamb's quarters in the field contained 114 eggs. The number of eggs normally laid by each female has not been completely studied, but is evidently large; [700 are recorded in one instance for *B. curialis* (3), while Masaitas ('25) reports that, when fed on syrup under experimental conditions, individual moths of *B. brassicae* may live as long as 24 days and lay over 2,000 eggs]. Only a few days are required for hatching.

Larvae in the earlier instars are essentially solitary in habit, and are mostly nocturnal except when feeding in entirely concealed situations. In the later one or two of the six larval stadia, the habits (as well as the appearance) become more variable. The majority of the larvae observed attacking marigolds, pea-vines,. etc., were nocturnal feeders, hiding during the day among debris or vegetation on the soil surface or even burrowing slightly into the earth. Very few of those feeding on cabbage or corn, or boring into pods of peas or beans, abandon their positions during the day. When attacking cabbage, the larvae usually work their way in as far as possible through the loose outer leaves before commencing to feed; they then continue to bore inwards, their meandering burrows often extending a radial distance of from 3 to 5 inches into the solid head, thus spoiling much more material than is actually consumed.

When on flax, sweet clover, pigweed, etc., the older larvae usually remain on the heads throughout the twenty-four hours, although fully exposed to bright hot sunshine or cold beating rains. Slow, but definite, directional migration of such larvae, when numerous, has been observed on a number of occasions. Notwithstanding, the considerable period of moth emergence and flight, it is evident that the majority appear within a short time and that the greater part of the oviposition occurs within a fairly short period. It is found that, in most seasons, the great mass of larvae consequently reach the final instar within a few days of one another. Usually, the inconspicuous and less destructive earlier stages have not been noticed by farmers, and the sudden appearance of large numbers of rather brightly marked, very voracious larvae in the last instar is very alarming. A few larvae begin to reach maturity soon after the middle of August in the average year, but the majority not until the early part of September.

The mature larvae enter the ground to a depth of a few inches, form a cell, and, after a short prepupal period, change to the pupal stage, in which hibernation occurs. The majority of the pupae exhibit a very well established dormancy in an early stage, with no visible signs of further development until a short time before emergence in the spring. While no extensive experiments have been undertaken, it is evident that a considerable period of time is a normal requisite to further development, which seems not to be materially accelerated by a moderate length of exposure to cold. Curiously, in the laboratory, a very small percentage of the pupae develop without undue delay, the moths emerging in about three weeks. The same phenomenon evidently occurs in nature, as evidenced by the capture late in each fall of a very few newly-emerged moths. In this locality at least, these do not constitute even a partial second brood in any true sense, but undoubtedly perish not long after emergence.

NATURAL CONTROL. The more important natural control factors observed in the investigations have been—mortality of the hibernating pupae, destruction of maturing larvae by flocks of crows, and disease among the larvae. Of these, the first is undoubtedly the most generally effective, and appears largely responsible for the marked sporadicity of outbreaks in a locality. In the instance of the 1922 outbreak on flax near Moose Jaw, Sask., a careful correspondent, L. W. Ashton, reported that, while very numerous healthy pupae could be found by a little digging in the fall, only an extremely small proportion of those dug up the following spring were alive, the majority being in various stages of decay; incidentally, the species was entirely unimportant in this district in 1923. The variations in pupal mortality under different field and weather conditions have not been worked out.

In nearly all outbreaks, the destructiveness to such crops as flax and sweet clover has been greatly reduced by the activities of flocks of crows feeding upon the armies of larvae. In several instances the numbers were so reduced that infestations, which had threatened the entire destruction of the crop in certain fields, caused a final net loss of less than 25 per cent.

The observed maximum larval mortality caused by disease, was 40 to 50 per cent. This occurred at Wauchope, Sask., in 1925, under conditions of frequent rains, high humidity coupled with high temperatures, and a very heavy infestation.

Field collections of eggs have been too few to give any indications as to the importance of egg parasitism, which is one of the most important factors recorded for *B. brassicae* (vide Voelkel '25, Luchnik '26 et alii). The rate of parasitism of the larvae is surprisingly low. The highest recorded was on flax at Wauchope in 1925,—the infestation being in its second year,—and did not exceed 25 per cent. The greater part of this parasitism was by *Paniscus?* sp., a tachinid being the only other parasite secured.

Under conditions of heavy rains a small proportion of the larvae on cabbage are killed by drowning in the accumulation of moisture at the bases of the outer leaves.

DIFFERENTIATION FROM SPECIES OF SIMILAR APPEARANCE OR HABITS. Under ordinary laboratory conditions, the pupae are very hard to rear, the great majority dying during the winter or producing very imperfect moths. Most of those which die are too immature to permit identification by dissecting out the moths. Even when good moth specimens are secured, it is usually only after a delay of some months, and from such a small proportion of the variable larvae as to cast much doubt upon the identity of the remainder. Under the circumstances, it is not surprising that the species has been variously determined by entomologists well acquainted with cutworm work, tentatively as *Scotogramma trifolii* Rott., *Heliothis obsoleta* Fab., *Cirphis unipuncta* How., *Agrotis c-nigrum* L. or *A. unicolor* Wlk.

Fortunately, it has been found possible to distinguish *Barathra* from these with complete certainty, without rearing to the adult stage. The pupal morphology is most useful, although the determination may often be made earlier, on the basis of superficial characters of the larvae and a knowledge of the habits and type of seasonal rhythm of the several species.

The clover cutworm, *Scotogramma trifolii*, occurs in numbers upon lamb's quarters in Saskatchewan, while a few have been taken feeding on sweet clover. It is also known to attack beets and other food plants in common with *Barathra*. The more typical last instar larvae of the latter are at once distinguished by the black dorsum. The mottled and pale larvae have not yet been clearly differentiated, on superficial characters, from those of *trifolii*, although the latter are usually dull green with the substigmatal band pinkish with white borders. The teeth of the mandibles are longer and more pointed and there is no toothlike structure on the inner face. The pupa of *S. trifolii* is distinguishable at a glance by the smooth, short, truncate cremaster (Fig. 20–3), and the very wideset terminal spines, among other characters. The moth also emerges without delay from the pupa.

Both in character of the injury and in appearance, some of the larvae of *Barathra*, found in the ears of corn, very closely resemble those of the corn earworm, *Heliothis obsoleta*, the two sometimes occurring in the same field. The larvae are easily separated because of the numerous fixed spinules on the cuticle of the latter species, and the rather slight indentations of its mandibles. The pupa is distinct on a number of characters: the virtual absence of a cremaster and the fact that the caudal extremity is blunt and smooth; the somewhat slighter, shorter terminal spines, without button;

the mesothoracic legs considerably longer than the antennae; the maxillae not reaching the caudal margin of the wings on the venter; the metathoracic legs rather large and meeting medially; there is no delay in development unless retarded by low temperatures, the moths emerge in a short time.

The more typical mature larvae of *Barathra* (Pl. 6–2) are rather similar to those of the armyworm (*C. unipuncta*), but the habits are usually distinct, since the latter show a strong preference for grasses, which are almost never attacked by the former. The colour pattern is distinguishable on close examination, and the mandibles of *unipuncta* show only two teeth, which are obscure. The pupae are very distinct, both from the single row of deep pits dorsally along the cephalic margin of abdominal segments 5, 6 and 7 and by the two pairs of slender, hooked setae on the dorsum, near the base of the terminal spines of the non-rugose cremaster of *unipuncta*.

The majority of the mature *Barathra* larvae feeding in cabbage heads, and many of those in corn ears and some other situations, would, from their general appearance, be placed at once, by those familiar with the spotted cutworm and the W-marked cutworms, as belonging to one or other of these two species, particularly the former *A. c-nigrum* (cf. Pl. 6–1). The character of the seasonal rhythm eliminates this possibility, since both *A. unicolor* and *A. c-nigrum* in this, as in other regions, hibernate as partly grown larvae, mature late in the spring, and are present in the moth stage during the time that the larvae of *Barathra* are causing their depredations. The larvae have not been examined for distinctive characters but should there be doubt, the pupae are separable both by the fact that they exhibit no tendency to dormancy, and by the two pairs of slender, hooked setae on the dorsum of the cremaster, in addition to the stout terminal spines. The cremaster of *c-nigrum* is smooth, also, and its terminal spines are set distinctly apart.

DISTRIBUTION AND HISTORY OF OUTBREAKS. The recorded captures of moths of *Barathra configurata*[7] correspond roughly in distribution with the transition zone of Merriam, extending along the Rocky mountains from Mexico to British Columbia and widely in the Prairie Provinces. The species seems to be definitely associated with the drier or grassland areas but is also taken well within the margin of the savanna.

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[7] The moth records now available to the writer are:—Mexico (Mexico City), New Mexico (Durango, James Springs, Las Vegas, Hot Springs, Fort Wingate), Arizona (Prescott, Cochise Co.), Colorado (Denver, Oak Creek Canyon, Fort Collins), Utah (Cedar City, Vineyard), Montana (Bozeman and South Cottonwood Canyon, Gallatin Co., Hamilton), British Columbia (Lilooet and the Fernie District), Alberta (Lethbridge; also distributed probably throughout the southern half of the province), Saskatchewan (a large number of points representative of the area from the international boundary to well within the popular savanna belt), Manitoba (Aweme, Miniota). In contrast, the moth records for *B. curialis* are invariably from areas of forest or savanna, chiefly in the eastern provinces of Canada (Ontario, Quebec and the Maritimes), the New England States and New York, but including also records for Edmonton, Alberta and Kaslo, British Columbia. For most of these records the writer is indebted to the Wm. Barnes Collection, the United States National Museum, the Montana Experiment Station, and the Canadian National Collection.

The outstanding feature of the known outbreaks of *B. configurata* has been their marked sporadicity both in time and in space. Seldom has severe injury occurred in two successive years in any small locality, although often there is slight damage in the year preceding an outbreak. In a very few instances, damage in three successive years has been reported by the same grower; where this occurred, there was usually a heavy outbreak in one year with lesser infestations during the year preceding and that following it. Another feature of the more widespread outbreaks has been the great local differences in intensity.

Economic infestations have been definitely recorded only in Western Canada. The first authentic economic record was for flax in the Moose Jaw district of Saskatchewan in 1922. The following year slight damage was recorded only for two points in southeast Saskatchewan in a district where heavy infestations occurred in 1924. The outbreak of 1925 was probably the heaviest and most widespread that has yet occurred in Saskatchewan, the area extending diagonally in a broad belt from northwest of Saskatoon to the southeast corner of the province. In 1926, the species was only moderately abundant, this time at a number of scattered points in central and west central Saskatchewan, an occurrence which seemed to presage the heavy outbreak in these districts during the past season (1927). In Alberta, H. L. Seamans states that commercial damage had not been observed prior to 1925, and only slight losses that year and in 1926. In 1927, the outbreak was very heavy over the greater part of the province south of Edmonton, involving the loss of several hundred acres of crop of various kinds. It also extended into the adjacent Fernie district of British Columbia. Considerable injury to sweet clover in Manitoba was observed by Norman Criddle in 1925 and 1927, extending from the Treesbank district to the southeast corner; the infestations on the whole were not very heavy. The outbreak of 1925 almost undoubtedly extended into the northwestern part of North Dakota.

OUTLOOK FOR THE FUTURE. All the information at hand indicates that this species is gradually increasing in importance as an agricultural pest. Of particular significance in this respect are the light-trap records of the Lethbridge laboratory, Alberta, taken in conjunction with other observations reported above. The light-trap has been kept under virtually standard conditions, and complete records have been kept each season beginning in 1921. For *B. configurata* these were:—1921—no moths, 1922—3, 1923—12, 1924—16, 1925—37, 1926—33, 1927—53. In Saskatchewan, there are dependable reports of slight economic importance of the species at a few points as early as 1915 or 1916, although the first outbreak record authenticated by rearing, was, as previously stated, for 1922. In spite of the marked fluctuations in numbers, there is little doubt that the general trend has been decidedly toward an increase in range, in intensity of infestation, and in the rate of damage. There is reason to believe that, until fairly recent years, *B. configurata* was living in native situations, upon various wild flowers and occasional small patches of "weeds." From this, only a slight adaptation was needed, to permit multiplication upon the widespread areas of favoured crop plants, and weeds of cultivated fields. The considerable variations in morphological characters, habits, and appearance of the larvae, seem to be significant of a lack of homogeneity and of a transitional condition of the species. If this is true the economic potentialities are increased. The observed non-dormancy of a small proportion of the pupae may indicate the increase of the species in a two brooded condition, in areas of longer seasons.

The confusion of the larvae with other species and the great difficulty of rearing adults for identification, strongly suggest that *B. configurata* has been troublesome over a considerably wider territory than is shown by the fully authentic records. At Bozeman, Montana,[8] for example, pupae of this species were found in some numbers in a garden in May 1917, and again in May 1918, which, in the light of present information, may have resulted from a moderate infestation on garden plants the previous summer.

In the present area of heavy infestation, the most serious threat is in the damage to sweet clover, in view of the increasing importance of this crop in the agricultural scheme. From the known habits of the genus, the developments on sugar beets and on cabbage should also be closely watched.

NOTES ON MEANS OF CONTROL. Few definite data have been secured in reference to means of control. In part, this is due to the sporadic nature of the outbreaks, and the fact that the infestations, which are usually not observed by growers until the appearance of the conspicuous and voracious swarms of last stage larvae, are seldom reported until the damage is nearly complete. This sporadicity also renders difficult the use of control measures at the proper time and place, and creates both a need for a method of forecasting outbreaks from meteorological conditions, and an opportunity to work it out when there are secured a greater number of accurate and definite records of outbreaks, together with further observations on limiting factors.

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[8] Records made available by the Montana Experiment Station through Dr. W. C. Cook; the rearings were by the present writer, at that time student assistant at Bozeman.

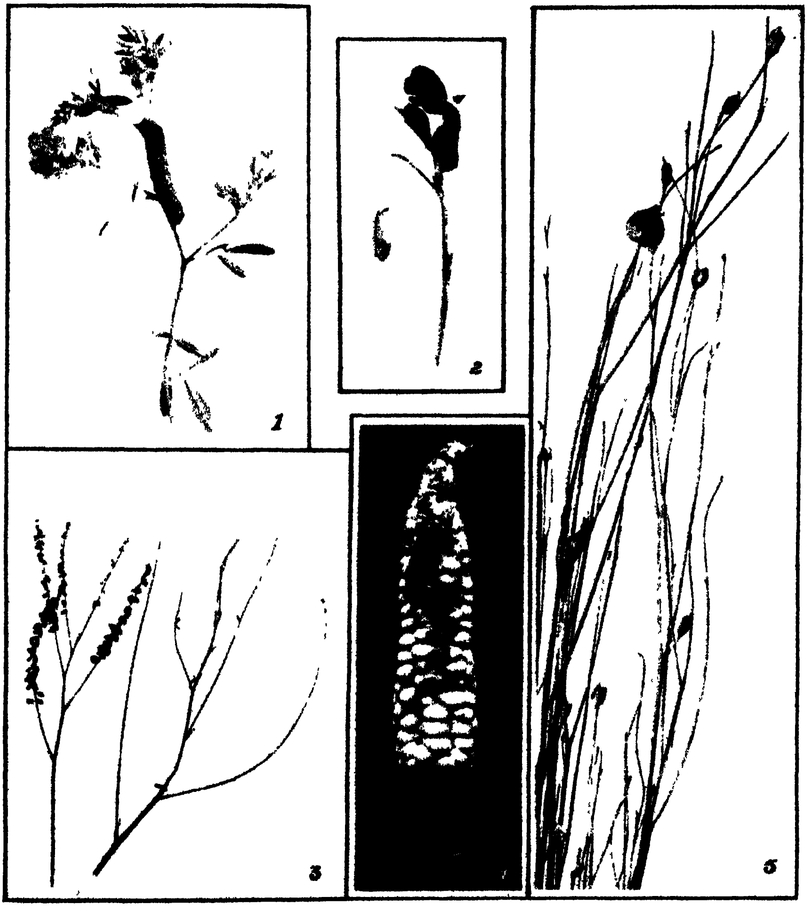
Ploughing, particularly in the fall, for the destruction of pupae, has been found to be of much value, but depends for best results on a popular knowledge of the species, so that the method can be applied during the season prior to a threatened outbreak, and to infested patches of lamb's quarters as well as to infested crops.

In heavily infested fields of sweet clover, alfalfa or flax, dusting with an arsenical has afforded excellent control in a few instances in Alberta, but it is doubtful if this method would at present be practical in connection with the present type of farming. Poisoned bran bait has been used with success under some conditions (Fletcher '06). The control on cabbage has been found particularly difficult. Pyrethrum dust has not been found effective against the larger worms, although easily destroying the larvae of *Pieris* which were more exposed. Furthermore, the use of an arsenical dust in two or three applications, beginning fairly early in the period of cabbage growth, was not effective in at least one instance, doubtless due to the habits of entry of *Barathra* larvae.

SUMMARY. The bertha armyworm (*Barathra configurata* Wlk.), here discussed for the first time in the economic literature, has come into increasing prominence in Saskatchewan during the past several years, culminating up to the present in the widespread outbreak of 1927, which affected a large part of the Prairie Provinces. The known facts suggest the economic occurrence of this native pest during a longer period and over a wider territory than is generally known. Its evident potentialities, as well as present importance, are such that considerable watchfulness is justified.

A wide variety of crop-plants and weeds, chiefly broad-leaved, are attacked, commercial damage being recorded to flax, sweet clover, alfalfa, cabbage, sugar beets and corn. The larvae, which are active from midsummer to early fall, feed for the most part on the flowering and fruiting bodies, in infestations running as high as a million per acre. There is but one generation per year, hibernating in the early pupal stage, which is strongly dormant, and difficult to rear. The mature caterpillars show great variability, both in appearance and habits, so that they have frequently been confused with several other Noctuids. Characters are given which will permit accurate identification without rearing to adults.

Plate 6



Typical work of *Barathra configurata;* (1) and (2) two common colour forms of last stage larvae, feeding on alfalfa (Photos by H. Gray); (3) branchlets of sweet clover, that at right stripped of seed pods by this cutworm, as compared with uninjured twig at left (photo by Scamans); (4) injury to sweet corn (original); (5) mature heads of flax on which all the seed pods but one have been completely consumed by *configurata* larvae. (Original).

Natural control factors, particularly winter mortality, cause a marked sporadicity of outbreaks, both as to time and place. This condition lessens the immediate importance, but makes it much more difficult to undertake adequate control measures until methods of accurate local forecasting are devised.

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MR. ARTHUR GIBSON: It would have been interesting if Mr. King had brought with him a picture of the lady who suggested this name.

FIRST VICE-PRESIDENT W. P. FLINT: The next paper is by the same author.

ECONOMIC IMPORTANCE OF WIREWORMS AND FALSE WIREWORMS IN SASKATCHEWAN[1]

By KENNETH M. KING, *Entomological Laboratory, Saskatoon, Sask.*

SUMMARY[2]

The purpose of this paper is to present a detailed appraisal of the present situation in Saskatchewan of damage by wireworms and false wireworms in general, the future potentialities insofar as they can be gauged and the status of the several species involved, without discussion of remedies. It is a preliminary report, although based upon more than five years' work, much of which was of a quantitative nature.

Heavy infestations occur fairly generally throughout the western two-thirds of the province and in occasional fields in the eastern districts. The resulting crop losses in 1926 were estimated at three and one-half million dollars, largely on the basis of returns from the extensive crop reporting service of the Statistics Branch, Saskatchewan Department of Agriculture. This figure is believed to be near the mean annual loss in recent years. In 1927 in one 200 acre field, representative of heavy damage, the net loss was about four thousand dollars, eighty acres of wheat being completely ruined. In another field the yield was reduced about 50 per cent in 1925, but so evenly that the farmer scarcely suspected the extent of his losses. These instances are more or less typical of the conditions in many fields each year.

The distinctive features of the problem are, (1) occurrence of the most severe damage by wireworms, almost invariably, to the first crop following the summerfallow year in an infested field; and (2) the association of the heavier wireworm infestations, on the whole, with fields which for many years have been under continuous cultivation in small-grain rotations which do not include grass.

In view of the latter feature, a steady increase in importance of the problem would naturally be anticipated since many districts are of comparatively recent settlement and a large acreage of virgin land is coming under cultivation each year. This increase is amply substantiated by the known facts, particularly the discovery yearly both of new fields and new districts in which the wireworm infestation is just reaching the stage of "commercial" injury to field crops.

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[1] Contribution from the Division of Field Crop and Garden Insects, Entomological Branch, Detp. of Agriculture for Canada.

[2] It is expected that the full paper will appear in *Scientific Agriculture.*

More than a dozen species are involved in the fields which have been investigated. The prairie grain wireworm (*Ludius aereipennis tinctus* Lec.), which is outstanding at present, also appears to have the greatest potentialities for the future; it occurs independent of grass, although frequently abundant both in native sod of some types and in seeded pastures. *Cryptohypnus nocturnus* (Esch.) which ranks second in importance, is typically associated with soddy fields. Other wireworm species of outstanding importance in one or more of the fields examined are *Limonius pectoralis* Lec., *Ludius virens* (Schr.), *Aeolus dorsalis* (Say), and two undetermined species of Agriotini. Larvae of *Ludius limoniiformis* (Horn), *Hypnoidus dubius* (Horn), and *Ludius* near *resplendens?* are found in small numbers in cultivated fields.

False wireworms are of relatively minor importance as yet and the five species recorded in Saskatchewan occur only in the more arid part of the Province. *Eleodes extricata convexicollis* Blais. has been an important species in a few fields, while *E. tricostata* (Say) has done a little damage in gardens. Adults of *E. hispilabris* (Say) are commonly met with, but crop injury by this species has not been authentically recorded.

FIRST VICE-PRESIDENT W. P. FLINT: The next paper is by Messrs. Smith, Fisher and Guyton.

HOT WATER IMMERSION FOR BOXWOOD LEAF MINER CONTROL

By FLOYD F. SMITH, H. J. FISHER, and T. L. GUYTON,
Penna. Bureau of Plant Industry, Harrisburg, Pa.

ABSTRACT

During the season of 1927, the possibility of leaf miner (*Monarthropalpus buxi*) control by means of immersion in hot water was investigated. Spring treatments at exposures fatal to the larvae injured the buds but the plants recovered fully by mid-summer, due to adventitious growths. Later treatments after the spring growths had hardened gave satisfactory kill of the larvae without injury to the plants. With a lowering of the temperature of the water the period of immersion must be lengthened. The increasing susceptibility of the larvae as they increased in size with the advance of the season was very marked.

The boxwood leaf miner (*Monarthropalpus buxi* Lab.) was first recorded in this country by Felt[1] in 1910. Since that time various methods of control have been tried. Probably spraying with nicotine and molasses at the time of adult emergence[2] is the method most used. This spray to be effective must be timely and under average conditions does not give satisfactory control. In an attempt to find some method of control more practical for nursery conditions the following described treatment with hot water was given a trial during the growing season and fall of 1927. This treatment fits in well with the general nursery practice of transplanting growing plants in August and September; or for treating plants about to be shipped to a customer.

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[1] Journal of Economic Entomology, Vol. 3, pp. 340–342. 1910.

During the spring preliminary tests with hot water immersion were made with infested branches of box to determine the effect on the larvae, and with small potted plants for the effect on the host. From these tests it was concluded that injury to the developing buds and tender new growth was incurred at temperatures fatal to the larvae. However, by mid-summer the treated plants had completely concealed the injury by new growths from adventitious buds. In late June, infested potted plants from out of doors immersed in water at 120° F. for from five to ten minutes were uninjured and the young larvae and eggs were killed.

A nursery, growing a large amount of boxwood, placed at our disposal a block of 18 inch plants of *Buxus sempervirens* for use in tests. The equipment for immersing the plants consisted of one galvanized tank 24″ in diameter and 30″ deep, placed within another tank 30″ in diameter and 36″ deep, the space between being insulated with pulverized asbestos. The temperature was maintained during the period of treating by steam run into the tank. When electricity was available, agitation of the water was effected with an agitator made by attaching to an electric fan motor, a shaft, to which was soldered a six-bladed propeller cut from a piece of heavy tin. When electricity was not available the water was kept in motion by stirring with a paddle. In the tests the temperature was read at one minute intervals and did not exceed the readings indicated. At no time did it drop more than ½°F.

Each plant was dug from the nursery row with a good ball of earth about the roots. A piece of burlap was wrapped about the soil ball, the plant was inverted, and the top immersed in the water to the soil surface. After treating and removing the burlap, the plant was reset in the row, and those treated before mid-September were shaded[3] with branches for about two weeks to give protection from the direct rays of the sun.

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[2] C. C. Hamilton. Bulletin No. 272, Maryland Agr. Exp. Sta., Feb. 1925.

[3] Shading of all evergreen plants is recommended by nurserymen after transplanting in August or September.

TEMPERATURES USED AND RATE OF KILL OF LARVAE. Several plants were treated to the temperature and exposure given in Table 1. The results of the kill of the larvae and injury to the plants are also found in the table.

TABLE 1. RESULTS OF FIELD TESTS WITH HOT WATER IMMERSION AS A LARVICIDE FOR *M. buxi*

No. Plants	Temp. Water °F.	Exposure in Minutes	Date Treated	Date Examined	Larvae Dead	Larvae Alive	Plant Injury, Final Examination 12/5/27
1	116	3	7/18	10/27	23	165	None
1	116	5	7/18	9/9	10	104	None
1	116	7	10/14	10/24	87	1	Trace bleaching
1	116	10	7/18	10/24	21	117	None
1	116	10	10/14	10/24	193	0	Trace bleaching
1	116	15	10/14	10/24	120	0	Trace bleaching
1	118	5	7/18	9/9	8	119	None
1	118	7	10/14	10/24	164	0	Trace bleaching
1	118	10	7/18	9/9	32	80	None
1	118	10	9/21	10/3	101	0	Moderate bleaching
1	118	10	10/14	10/24	190	0	Trace bleaching
1	118	15	9/21	10/3	124	0	Moderate yellowing
1	118	15	10/14	10/24	174	0	Moderate bleaching
1	120	5	7/18	9/9	82	60	None
2	120	5	8/13	10/27	436	37	Trace bleaching
3	120	5	9/21	10/3	361	2	Trace bleaching
6	120	5	10/14	10/24	528	0	Trace bleaching on south sides
3	120	7	9/9	9/21	412	0	None
3	120	7	9/21	10/3	337	0	Trace bleaching
3	120	7	10/14	10/27	368	0	Trace bleaching
1	120	10	7/18	10/27	390	2	None
2	120	10	8/13	10/24	820	0	Trace bleaching
8	120	10	9/9	12/5	400	0	Trace bleaching
3	120	10	9/21	12/5	414	0	Slight bleaching
2	120	15	8/13	10/27	410	0	Slight yellowing
2	121	2	9/9	12/5	343	0	Trace bleaching
1	121	3	9/9	10/3	124	17	Trace bleaching
3	121	3	9/21	10/3	436	0	Trace bleaching
3	121	3	10/14	10/24	333	0	Trace bleaching
2	121	5	9/21	10/3	123	0	Trace bleaching
6	121	5	10/14	10/24	311	0	Trace bleaching
3	121	7	10/14	10/24	285	0	Slight bleaching
9	122	3	9/9	10/11	473	42	None
6	122	3	9/21	10/11	440	0	Trace bleaching
6	122	3	10/14	10/24	503	0	Trace bleaching
1	122	5	7/18	9/9	140	10	None

TABLE 1. CONTINUED.

No. Plants	Temp. Water °F.	Exposure in Minutes	Date Treated	Date Examined	Larvae Dead	Larvae Alive	Plant Injury, Final Examination 12/5/27
3	122	5	8/13	10/27	955	0	None
8	122	5	9/9	10/11	576	2	Trace bleaching
3	122	5	9/21	12/5	476	0	Moderate bleaching
5	122	5	10/14	10/24	562	0	Slight bleaching
1	122	10	8/13	10/27	176	0	Slight bleaching
2	122	10	9/9	10/27	381	0	Slight bleaching, trace yellowing
1	124	3	8/13	10/24	113	0	Slight bleaching
3	124	3	9/9	10/11	262	0	Trace bleaching
2	124	3	9/21	12/5	154	0	Slight yellowing
6	124	3	10/14	10/24	346	0	Trace bleaching
1	124	5	8/13	10/27	150	0	Slight yellowing
3	124	5	9/9	10/27	239	0	Slight yellowing
3	124	5	10/14	10/24	301	0	Moderate bleaching
1	124	7	10/14	10/24	116	0	Moderate yellowing
1	124	10	10/14	10/24	114	0	Severe injury, tips killed
1	124	15	10/14	10/24	81	0	Severe injury, tips killed
1	126	3	8/13	10/24	156	0	Moderate yellowing, tips killed
1	126	5	8/13	10/24	194	0	Badly yellowed, tips killed

EFFECT OF TREATMENT ON PLANTS. Because of the abnormally warm weather during the late fall months, many of the buds, which usually remain dormant until the following spring, developed young growths. The plants treated in October had this tender growth killed at all temperatures. This was in accord with the observations made in the spring tests.

Direct tissue injury to the mature foliage is evidently manifested by a gradual yellowing of the foliage and this color may be confined to the edge or include the whole leaf. The intensity of yellowing increases with the exposure and temperature. In the cases of slight or moderate yellowing, the buds and twigs are not injured.

The hot water treatment probably slightly dissolves the waxy covering of the foliage and may account for a bleaching of the leaves, especially at their tips, which may become evident in two to four weeks after treatment. The bleaching is confined to the south and west sides of the plants and was greatly reduced by shading with leafy branches.

The twigs and buds are unaffected by this type of injury. The bleaching is distinct from the yellowing just described.

The plants treated before mid-September developed new growths a little more extensively than the checks. The combination of the warm fall weather and the effects of the treatment seemed to encourage the breaking of dormancy. These new growths will probably winter-kill. Some undisturbed plants in the same block with the treated ones developed fully as much late growth.

Effect of Treatment on Larvae. All larvae of the leaf miner remain motionless for some time after treatment, but those which later die and decompose take on a less shining and more pallid or milky color within a day or two. The body remains turgid and decomposition

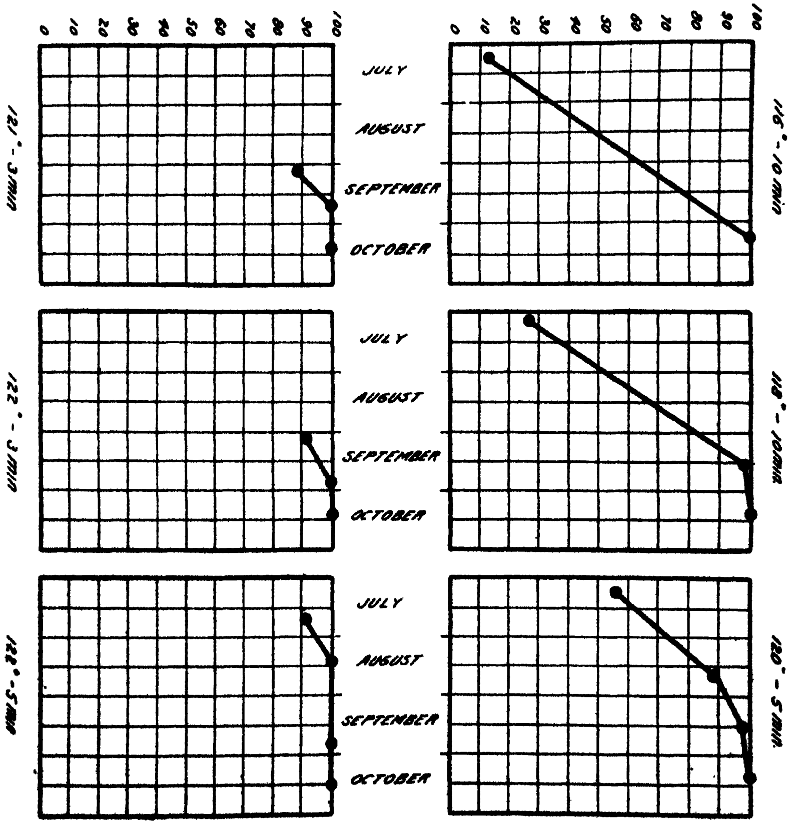

Fig. 21—Graph showing increased effectiveness of same treatment against *M. buxi* larvae with advance of season.

does not set in, usually, until after ten days. The tip of the abdomen first takes on a brown color and this color progresses forward to include the whole body, the latter then begins to shrink and in two to three weeks appears as a bit of thread in the mine. The larvae which recover become active after two to four days but at this time it is difficult, even with a glass, to determine accurately the motionless living ones from those which later decompose.

The increased susceptibility of the larvae to certain exposures, as the season advances, is very marked, as is shown by graph 1. The greatest increase seems to take place in early September and the following is offered as a possible explanation. Until early September we find the larvae increasing very little in size and the mines have not been greatly enlarged. Then larval feeding and growth become rapid and the leaf tissue is eaten away to near the lower epidermis. Heat penetration may then be more rapid and the larvae being in a state of higher metabolic processes due to increased activity in feeding and growth may be more readily killed. The larvae were in the first instar during the July treatments, probably in the second instar during the August and early September treatments, and in the third instar in the later treatments.

Comparative tests on the thicker leaved varieties of *Buxus sempervirens* such as var. *rotundifolia* or of *Buxus japonica* and its varieties were not made.

Oyster shell scale (*Lepidosaphes ulmi*) and a soft scale (*Lecanium corni*) were observed on some of the plants and the immersion at 120° F. for five minutes killed all that were examined.

CONCLUSION

As the season advances from mid-summer the larvae become more susceptible to hot water treatment.

Satisfactory control was obtained on *Buxus sempervirens* at 120° F. at the following exposures: during July and August, 10 minutes; early September, 7 minutes; last half of September and October, 5 minutes. Other temperatures at corresponding exposures may be substituted as indicated by the table of treatments.

Treatment in the spring injured the young tips at exposures fatal to the larvae, but lateral growths developing later concealed the injury by mid-summer.

Injury of the foliage by sun bleaching will usually follow the treatment to some extent but may be largely prevented by shading.

This form of treatment need not require more expensive equipment than is warranted by the value of the plants and fits in well with the regular nursery practices. This treatment is not intended for plants in permanent plantings.

MR. C. L. METCALF: I would like to ask why it is that these insects are more susceptible late in the season.

MR. T. L. GUYTON: We have not been able to determine that point unless it was that the leaves were not so well protected the last part of the season. That is the only reason we can figure out.

FIRST VICE-PRESIDENT W. P. FLINT: The next paper is by S. A. Graham.

THE INFLUENCE OF SMALL MAMMALS AND OTHER FACTORS UPON THE LARCH SAWFLY SURVIVAL

By S. A. GRAHAM, *School of Forestry and Conservation, University of Michigan, Agent, Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

This paper presents the results of a series of quantitative studies and experiments concerning the factors that influence mortality of the larch sawfly, *Lygaeonematus erichsonii*, in the cocoon stage. Facts are presented to show that the physical conditions that exist in the sphagnum moss in tamarack swamps are much more favorable for hibernation of the sawflies than are the conditions that are to be found under tamarack on high ground.

Of the biotic factors that operate to reduce the numbers of the sawfly in the cocoon stage small mammals, particularly mice, play a much more important rôle than do the insect parasites and fungus diseases.

During the last twenty years over 60 per cent of the tamarack in the Lake States over three inches in diameter breast high, has been killed. Throughout the swamp areas of this region the bare trunks of the dead trees still stand, to testify to the destruction of an amount of timber almost too great to conceive. It is possible to travel for miles through swamps once covered by magnificent tamarack forests without seeing a single living merchantable tree.

The cause of this great catastrophe was the larch sawfly, *Lygaeonematus erichsonii*. In spite of our long acquaintance with this insect both in Europe and in America we are still practically helpless when called upon to suggest means that are economically feasible for its control in our swamp forests.

Now that the outbreak has passed, the young tamarack that survived is growing and reproducing well, and is rapidly replacing the forest that was killed. Little thought was given to the destruction of the old tamarack for, at that time, this tree had comparatively little commercial value. Today, however, a very different condition exists. This species now has a very real value and if it were not for the larch sawfly menace it would doubtless play a leading rôle as a timber tree of the swamp forest.

Unfortunately, as the tamarack increases in size and abundance the sawfly likewise is making itself more or less conspicuous. During the past five or six years this insect has been rather numerous and in some swamps severe defoliation has occurred. In other areas the insect is not sufficiently abundant to be conspicuous. During the past three seasons, however, not a single swamp has been examined without disclosing more or less injury caused by this pest.

This condition has caused much apprehension on the part of those interested in swamp forests. Another outbreak such as the one that occurred a decade or more ago would now have serious economic consequences, and unless we are able to develop means of regulating the abundance of the sawfly another such great outbreak seems unavoidable.

The control of an insect such as this is a difficult matter, especially in view of the fact that the prospective value of a tamarack forest is usually not sufficient to justify the application of direct means of control. It seems certain that if the larch sawfly is to be economically controlled, this must be accomplished by the use of indirect or preventive methods. If we knew all the factors involved in bringing about an outbreak of this insect and if we could know all that there is to know about the environmental resistance that tends to hold the insect in check we might find this problem much less baffling than it now is.

Leading toward the discovery of some of these important facts quantitative studies of the larch sawfly and its enemies were undertaken by the author during his connection with the Minnesota State Experiment Station, and are being continued at the University of Michigan.[1]

Some especially interesting and valuable results have already come from studies of the larch sawfly during the cocoon stage and it has been demonstrated that among other factors during this period small mammals such as mice and shrews play an important rôle. The effect of these and other limiting factors will be discussed in this paper.

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[1] The data on which this paper is based are the joint products of the University of Minnesota, the University of Michigan, the Bureau of Entomology and the Lake States Forest Experiment Station.

Any year if all the larvae of the sawfly that reach full development and spin cocoons should emerge as adults there would be a very severe outbreak of the insect during the following season. But this has not happened in recent years. Fortunately only a very small proportion of the larvae that become full-grown ever reach the adult stage.

Many fail to survive the physical conditions of the environment with which they come into contact during hibernation. Only when the cocoons are so located that they are protected from drying and from sudden changes of temperature do the insects within them survive.

Hibernation experiments have been conducted that demonstrate this point rather conclusively. These experiments were carried on in the following manner. Sawfly larvae were collected and reared to maturity in trays and were permitted to spin cocoons. The cocoons were then placed in cages under a variety of conditions.

Some of the cages were placed in a swamp while others were placed beneath a stand of young tamarack on high ground. In the swamp one set of cocoons was placed on top of the sphagnum moss that covered the surface of the ground while another set was buried under 2 inches of moss. On high ground one set was placed on the surface, one set under the natural litter of tamarack needles, and a third set was buried, in the first series of experiments, beneath ½ inch and, in the second experiment, under 1½ inches of sand covered with tamarack needles.

Table 1 summarizes the results of these experiments. It will be observed that the most favorable of the conditions tested for the hibernation of the sawfly is to be found in the swamp buried in the moss. On high ground a considerable number of cocoons buried 1½ inches in sand produced a fair percentage of adults. Lest this may be misinterpreted it should be mentioned that the larvae seldom penetrate into the mineral soil when seeking a place to spin their cocoons, therefore the cocoons are seldom found naturally in this comparatively favorable situation. The cocoons as a rule rest just beneath the litter on the surface of the mineral soil. In such a place, the sawflies find much less favorable conditions for hibernation than if they were buried in moss. Perhaps the difficulty of finding suitable quarters for hibernation may account for the fact that the sawfly appears to be much less dangerous on the high land than in the swamp.

Another fact that should be mentioned here was brought out incidentally in the course of the hibernation experiments. It is interesting

TABLE 1. RESULT OF HIBERNATION EXPERIMENTS

Condition of Storage	Experiment Started Aug., 1924, Ended Aug. 17, 1926							Experiment Started Aug. 20, 1925, Ended Sept., 1927						
	Total No. of Cocoons	Emerged		Living in Cocoons		Dead in Cocoons		Total No. of Cocoons	Emerged		Living in Cocoons		Dead in Cocoons	
		No.	%	No.	%	No.	%		No.	%	No.	%	No.	%
Surface of moss in swamp...............	50	14	28	2	4	34	68	120	32	27	0	0	88	73
Buried 2 inches beneath moss............	50	16	32	0	0	34	68	120	76	61	5	2	39	37
Surface of needles in nursery............	125	5	3	0	0	119	95	120	0	0	0	0	120	100
Beneath Tamarack needles...............	42	8	19	0	0	34	81	120	6	5	0	0	114	95
Beneath ½ inch sand covered with needles.	43	0	0	0	0	43	100							
Beneath 1½ inches sand covered with needles								110	32	29	0	0	78	71

TABLE 2. COCOONS PER UNIT AREA OF 1 SQ. FT., MUD LAKE SWAMP[1]

Plot No.	Average No. per sq. ft.	Average No.	Normal	Killed by Disease		Parasitized		Opened by Mice	
		No. per sq. ft.	%	No. per sq. ft.	%	No. per sq. ft.	%	No. per sq. ft.	%
1	1.8	0.9	50	0.5	28	0.3	16	0.1	6
2	7.9	3.2	40	0	0	0.8	11	3.9	49
3	3.7	1.5	40	0.2	5	0.2	5	1.8	49
4	13.6	2.8	21	0.8	6	0.4	3	9.6	70
5	11.9	5.0	42	0.2	2	0.8	7	5.9	49
6	4.7	0.2	4	0	0	0.6	13	3.9	83
Average	7.3	2.3	31	0.3	4	0.5	7	4.2	57

[1] Data collected by class in Forest Entomology, University of Michigan.

to note that in each case at the end of the two year period of these experiments a small percentage of the insect was still alive in the prepupal stage within the cocoons. This indicates that the larvae sometimes hold over in the prepupal stage for a longer period than has previously been supposed.

From these experiments it is evident that in the swamp where conditions for hibernation are favorable, a large proportion of the hibernating larvae will pupate and emerge as adults if they were not prevented from doing so by factors other than those of the physical environment. It is here that parasitic and predaceous organisms play an important part. It is obvious that if a large part of the hibernating sawflies were not destroyed by their enemies the insect would soon build up to epidemic numbers. During the past four seasons, judging by the proportion of new shoots showing oviposition injury, the number of adults emerging in the spring has remained approximately the same. The average percentage of tips injured by sawfly oviposition in and around Itasca Park Minnesota during that period has been about as follows:—1924—8.9% 1925—8.1%, 1926—10.1%, 1927—6.9%.

There is therefore no evidence that there was, during that period, any appreciable increase in sawfly abundance in that region. Similar conditions have apparently prevailed in the swamps about Ann Arbor, Michigan. The sawfly has been present each year in considerable numbers but it has not been able to make any marked gain in abundance.

In order to obtain information concerning the various factors that tend to reduce the numbers of this insect during the cocoon period an intensive study was made of a swamp area near Ann Arbor, Michigan. These data were collected by the author's class in forest entomology. Table 2 illustrates the effect of insect parasites, entomophagous fungi, and mice in reducing the numbers of the larch sawfly.

These data were collected on a series of six 1/10 acre sample plots placed at regular intervals. On each plot a series of ten small plots, 1 square foot in area, were laid out along a diagonal of the larger plot. The moss on each of the small plots was carefully dug up and examined for cocoons. All the open cocoons found were sorted into four groups as indicated in Table 2. It is interesting to observe that in this swamp the parasitic insects and entomophagous fungi as compared with mice are comparatively unimportant in destroying the prepupae of the sawfly. The term mouse is used here in the broad sense. In this swamp an average of less than 10 per cent was killed by the first two agencies combined whereas an average of 57 per cent of the cocoons had been opened by mice. Cocoons opened by mice can easily be distinguished from normally opened cocoons by the marks of the incisor teeth around the edges of the openings.

On the basis of random collections in and about Itasca Park, Minnesota, it was found that a similar condition existed there. Parasites and fungus diseases were even less important than in the swamp studied above, amounting to only 5 per cent or less, whereas the proportion of the cocoons that had been opened by rodents varied between 79 and 95 per cent. Hewitt[2] reports that during 1907 and 1908 a field vole or meadow mouse, *Microtus agrestis*, was an important factor in destroying hibernating larvae of the larch sawfly in the Lake District of England. He also reports the white-footed mouse as responsible for similar work in America, but he apparently did not make any personal observation on the work of these rodents in America. He assumes that in the instances to which he refers the sawfly provided a rather unusual type of food for these phytophagous animals and infers that only when the sawfly becomes extremely abundant do the mice feed upon them. Our observations, however, lead us to conclude that mice are much more omnivorous than is usually considered to be the case and that insects normally comprise a considerable part of their diet at certain seasons of the year.

In an attempt to determine what rodents were feeding upon the sawfly larvae, traps were baited with fresh cocoons. At first the cocoons were placed loosely upon the pan of the traps. In a large number of instances the bait was removed and eaten without springing the trap. Therefore the cocoons were fastened firmly to the pan after which a large percentage of catches was made. During a short period of trapping 10 mice were captured. They were all voles or meadow mice belonging to the genus Microtus and apparently all belonged to the same species.

In addition to the mice 6 shrews were also captured in the traps baited with fresh cocoons. An examination of the stomachs seemed to indicate however that these animals were feeding, if at all, only incidentally upon the sawfly prepupae, as their stomachs were filled with legs and wings of beetles and ants but none of the hard parts of the sawfly larvae could be found. The stomachs of the mice, on the other hand contained a very large proportion of insect fat, presumably from the sawfly prepupae.

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[2] Hewitt, C. Gordon. The Large Larch Sawfly, Bul. 10 Dom. Can. Dept. Agric. Ottawa 1912.

A mouse in eating a larva first opens a hole through the cocoon. Then it cuts through the skin of the larva and extracts the soft tissues from within, leaving the skin and hard portions of the exoskeleton. Thus the fat body is practically the only structure that is recognizable in the stomach. On the basis of stomach examinations we are inclined to believe that after the larvae have spun the cocoons the mice are a more important factor in the control of the sawfly than are the more highly insectivorous shrews. Inasmuch as no actual evaluation of the effect of shrew activity has been made further evidence may alter this conclusion.

In collecting the data concerning the effect of parasites and predators referred to above it was found impossible because of their durability to distinguish between cocoons of different seasons. Therefore these data give a cross section of the effect of these factors over a period of several years. In order to measure the effect of these agencies for a given season it was necessary to develop special methods. The method finally adopted measured comparatively the abundance of mice and shrews on each area studied in terms of their effect upon a constant number of fresh cocoons distributed in a uniform manner over the area. On 1/10 acre plots ten stations were located on a diagonal. These stations were spaced at equal intervals and each was marked by a flagged stake. Five fresh cocoons of the larch sawfly were tied in square pieces of cloth to form a sort of bag and at each stake one of these sacks of cocoons was buried beneath the surface. The string used in tying each sack was long enough to tie around the base of the marking stake so that the sacks might be found easily.

Cocoons were placed in this manner on 12 sample plots on August 24, 1927. On November 4th of the same year a preliminary examination was made, the results of which are set forth in Table 3.

This table shows clearly that the small mammals are in some cases very thorough in their search for cocoons. An average of all the plots showed a total destruction by November 4th of 55 per cent of the cocoons. Doubtless this work will continue throughout the greater part of the winter.

On the different plots there was considerable variation, from 20 to 78 per cent, in the number of cocoons destroyed. This variation is interpreted to indicate that the abundance of the animals concerned varied in the same proportion.

Several facts indicate that this is actually the case. For instance on the plots where a variety of plant species in the ground cover makes

TABLE 3. MEASURING ABUNDANCE OF SMALL ANIMALS BY PLANTED SAWFLY COCOONS

Plot	Bags Opened	Cocoons Gone	Bags and Cocoons Gone		Total Per cent	Undisturbed	
No.	No.	*Per cent*	*No.*	*Per cent*	destroyed	*No.*	*Per cent*
1	3	30	2	20	50	5	50
2	1	10	6	68	78	3	32
3	7	78	0	0	78	3[1]	22
4	5	50	0	0	50	5	50
5	4	50	2	25	75	4[2]	25
6	5	50	0	0	50	5	50
7	5	55	1	11	66	3	33
8	2	20	0	0	20	8	80
9	4	40	2	20	60	4	40
10	5	50	2	20	70	3	30
11	2	20	1	10	30	7	70
12	6	60	1	10	70	3	30
	—	—	—	—	—	—	—
Total	49	41	17	14	55	53	45

[1] Cocoons covered with mycelium of a fungus. In one instance larvae dead. Dropped in calculating per cent.
[2] Cocoons covered with mycelium of a fungus. In two instances larvae dead. Dropped in calculating per cent.

Plot 6 Located between grass and sphagnum type—All surviving cocoons on grass end of sector.

for stability of food supply for such animals as mice, as is the case on plot 2, a very large proportion of the cocoons had been destroyed. The mice in this instance could not have been forced, because of the scarcity of food, to search out the sawfly cocoons because food was obviously abundant on the plot, therefore it seems logical to conclude that the destruction of the cocoons was the result of the abundance of the rodents that one would naturally expect to find in a place where an abundant and constant supply of food was available for them. This conclusion is further substantiated on plot 8. On this plot the ground cover is practically limited to sedges and sphagnum. There was obviously very little food for mice on that area and in that case only 20 per cent of the cocoons had been destroyed.

Plot 6 is especially interesting in the same connection. One part of the plot lies near the edge of the swamp where the ground cover is varied and abundant, and the other part has a ground cover of sphagnum and sedges. On this plot none of the cocoons buried in the moss-sedge area were disturbed, whereas on the other part of the plot every cocoon was gone. From these observations it would appear that the comparative abundance of mice and other small mammals that feed upon the hibernating prepupae of the sawfly, may be measured by the effect of these animals upon a constant number of fresh cocoons distributed over a given area in a uniform manner.

Summary and Conclusion

The larch sawfly, *Lygaeonematus erichsonii*, is one of the very important defoliators of the northern swamp forest and during the past twenty years has reached epidemic proportions and killed an amount of tamarack timber almost too great to comprehend. The young trees that survived this outbreak are growing and reproducing well but the sawfly is a continual menace to this forest.

Unless practical control measures can be developed it is almost certain that another such outbreak will occur in the future, and will then cause a much greater economic loss than the last outbreak because of the present increased value of tamarack timber.

Inasmuch as direct methods are too expensive to use in the control of this insect in tamarack forests it is necessary that indirect or preventive methods be developed. With this in mind a series of experiments is now under way to determine methods of silvicutural management that will reduce the danger of sawfly outbreaks, in the future This work is being conducted cooperatively by the University of Michigan, the University of Minnesota, the Lake States Forest Experiment Station and the Bureau of Entomology, United States Department of Agriculture.

This paper reports preliminary results of a series of experiments to determine the effect of certain environmental factors in reducing the numbers of the sawfly while in the cocoon stage.

Hibernation experiments show that the sawfly is best able to pass the winter buried in the sphagnum moss so characteristic of the swamp forest. Thirty to seventy-six per cent of them winter successfully under this condition. On high ground successful hibernation is very difficult. This would seem to indicate that on well-drained soil where there is no moss ground cover the tamarack might not be severely injured by the sawfly.

Of the biotic factors that tend to reduce the numbers of sawflies during the cocoon stage, insect parasites, entomophagous fungi, and certain small mammals are important. Of these the small mammals are by far the most important. Parasitic insects and fungi kill less than 10 per cent of the prepupae whereas mice and shrews destroy, on the average, from 50 to 80 per cent. Mice appear to be more important than shrews in this work.

The effectiveness of mice in destroying the larch sawfly prepupae varies with the natural abundance of these animals. In those swamps or parts of swamps where the ground cover is made up of a great variety of woody and herbaceous plants, mouse food is abundant, and the mouse population is great. The destruction of sawflies is likewise great. On the other hand when the ground cover consists primarily of mosses and sedges food for mice is comparatively scarce, and as a result the mouse population and the destruction of sawflies by them are correspondingly less.

The experimental results presented in this paper show that we may find some of the most important factors of environmental resistance in unexpected places. Before undertaking this work it was certainly not anticipated that mice might be found to play such as important rôle as benefactors of the forest. Usually these animals are regarded as pests and anything that will reduce their numbers is welcomed. From the evidence presented here, however, it is evident that if any catastrophe should overtake the mouse population in our tamarack forests a serious outbreak of the larch sawfly would almost certainly result.

FIRST VICE-PRESIDENT W. P. FLINT: The next paper is by A. F. Burgess.

Instead of reading his paper, the author showed a motion picture of the progress made in the gipsy moth infested area in New England and New Jersey.

FIRST VICE-PRESIDENT W. P. FLINT: The next paper is by J. S. Houser.

THE EUROPEAN RED MITE, *PARATETRANYCHUS PILOSUS*

By J. S. HOUSER

ABSTRACT

Early season development of red mite is reported as profuse on lime sulfur sprayed plots and meager on oil sprayed plots. By the end of the season the conditions were reversed, having been brought about in large measure through the biological control effected by the lady beetle, *Stethorus punctum* Lec.

It is generally conceded that dormant applications of lime sulfur cannot be depended upon to destroy the overwintering eggs of the European red mite while the reverse may be expected of dormant strength oil emulsions and miscible oils. Indeed it has now become an established practice among entomologists to recommend oils where orchards are known to be heavily infested.

During the course of the several years the writer has conducted spraying tests against this pest, early season observations made after the mites began to hatch invariably have yielded the record that mites were plentiful on the foliage of the check and lime-sulfur plots while they were either absent or very scarce in the oil sprayed plots. The past two years, however, observations taken in early fall have indicated that an absolute reversal of the situation had occurred sometime during the summer. In other words, in the fall the lime sulfur plots were practically free from overwintering eggs while the oil sprayed plots were heavily infested.

The biological successions involved in effecting this reversal were so plainly evident in one orchard in 1926 that the story was as plain as the printed page. A block consisting of ten rows of plums in an orchard near Toledo was sprayed in the spring of 1926 with lime sulfur and oil; two rows on the east having received lime sulfur and the remainder oil. Early in the summer the infestation was so severe on the lime sulfur sprayed trees that the foliage turned gray and as the season progressed much of it dropped. The yield of plums was much reduced by dropping and by reason of decreased size. Conversely the oil sprayed block at the outset was in good condition with few mites present, but as the season progressed the infestation spread westward, with the rows nearest the lime sulfur sprayed block most heavily involved.

By the end of the season few mites or overwintering eggs were to be found on the lime sulfur sprayed trees, with the infestation of both gradually increasing in intensity as one progressed westward through the oil sprayed block until a point was reached a little beyond the center when the numbers again decreased. The condition was puzzling until it was observed that in the area where the mites were most plentiful there were present great numbers of the lady beetle, *Stethorus punctum* Lec., feeding upon both eggs and mites. Evidently this predator had been attracted to the infestation of the lime sulfur block and after cleaning it up had followed the mite scourge westward but had been unable to keep pace with it, hence the mites outstripping their pursuers had been able to deposit great numbers of overwintering eggs. The most westerly rows in the oil sprayed block had on them fewer eggs simply because the mite scourge had not progressed that far.

An incident somewhat similar to the above was observed this past season at Chardon, Ohio, where an extensive block of apple sprayed with oil was at the close of the season heavily infested with European red mite eggs while a similar block sprayed with lime sulfur in the spring and heavily infested during the summer was comparatively free from eggs.

Experiences such as the foregoing might lead one to speculate, as did Dr. C. L. Marlatt in his famous presidential address on The Laisser-Faire Philosophy applied to the insect problem delivered nearly thirty years ago before this Association. That Marlatt's "let alone" policy might be best in red spider control, should we measure the success of the oil treatment by the comparative numbers of overwintering eggs at the end of the season between that and lime sulfur which we admit is a poor remedy. Due to the fact that oil sprays seem to badly disturb the natural balance existing between the red spider and biological control, might it not be better to let nature take its course in such a case? Theoretically, a natural balance might soon result.

However, due to the fact that biological agencies are more or less uncertain and applications of oil are so positive in their effects when measured by the standard of fruit produced rather than that of numbers of overwintering eggs at the end of the season, there seems little doubt but that the practical thing to do is to recommend oil applications in the spring when red mite eggs are abundant.

FIRST VICE-PRESIDENT W. P. FLINT: The next paper is by J. G. Sanders.

OBSERVATIONS ON EUROPEAN RED MITE (*PARATETRANYCHUS PILOSUS* C. & F.)

By J. G. Sanders

Abstract

Orchard spraying practices are being revolutionized by another introduced pest wherever it is well established and favorable conditions for its rapid propagation exist. The European red mite, *Paratetranychus pilosus* C. & F., year by year is becoming a decided factor in the alteration of standard spray practices in apple, peach, plum, prune and cherry orchards.

During the years 1918 to 1920 this relatively new pest attracted the attention of growers in several localities in the eastern states and in eastern Canada. Attention was drawn to the peculiar bronzy appearance of badly infested apple foliage which, in the growers' lack of knowledge of the pest and its type of injury, was frequently ascribed to lack of fertility. Even at this date relatively little information on this pest has been disseminated by our experiment stations and horticultural papers although considerable injury and consequent heavy loss of fruit crops have occurred in several regions.

The growing mites attack the foliage of our common fruits and interfere with the normal functions apparently by extracting the chlorophyll and perhaps by a vague poisoning of the tissues.

During the past four years the writer has had an excellent opportunity to observe this pest in many localities in the eastern United States and Canada. It is interesting to note that in regions which are quite generally infested there will be found occasional isolated orchards composed of old trees only in which no red mite will be found. If replants have been made recently in these old orchards, the red mite will usually be found. Likewise, most of the younger orchards are infested with this pest, indicating that it is being widely distributed in recent years by means of nursery stock.

In some sections and on certain varieties, such as Baldwin, Gilliflower and McIntosh which are very susceptible, the damage to foliage by the red mite exceeds that caused in ordinary seasons by scab and "frog eye." It seems desirable to call the attention of entomologists and horticulturists generally to the exceptional amount of injury which can result from a serious infestation of red mite in order that the importance of the pest may be brought to the attention of the growers and losses checked.

There is plenty of evidence to prove that sulfur compounds, as ordinarily applied in dormant or delayed dormant sprays, will not kill a sufficient number of the overwintering eggs to warrant any reasonable control throughout the season, although several experiment stations have stated that lime-sulfur is an effective control. The red mite has been observed on many occasions to multiply more rapidly during the summer in dusted orchards than in those which are regularly sprayed with lime-sulfur solution.

It is a well established fact in several of the infested fruit growing regions that petroleum sprays are far more effective than sulfur compounds and therefore they are being rapidly adopted and applied every year in the delayed dormant period or slightly later, if safe. The 2 per cent lubricating oil emulsions have not appeared to give sufficiently high kill to warrant their use in view of the rapidity with which the mites develop in recurring generations in the summer from the 10 to 12 per cent of eggs apparently unaffected by the emulsions. Again it appears that the heavier miscible oils are more effective than the lighter fractions in killing red mite eggs.

As shown by the careful tests of Garman in Connecticut and Bourne in Massachusetts, a higher percentage of egg kill can be obtained with the same petroleum sprays the longer application can be delayed in the spring. Therefore, those petroleum sprays which can be applied safely as the apple buds are opening or during the few succeeding days of development will give the more effective control.

In the New England states it has been found necessary to apply petroleum sprays each spring very thoroughly to insure a reasonable protection throughout the summer and even with what appears to be a thorough egg kill, before the summer is passed, under favorable conditions, a certain amount of reinfestation occurs through the rapid development of broods or from transfer and carriage by winds or by other natural methods.

It appears that with the rapid establishment of this introduced pest that the ordinary spray schedules must be revised to include an adequate control for protection of orchards.

MR. W. O. HOLLISTER: In the spraying of conifers for red mite, do they stand the oil?

MR. J. G. SANDERS: Certain of them will. You are dealing with an entirely different species on the conifers. But one per cent oil applied in summer, that is the heavier oil, properly and thoroughly emulsified is usually an effective control.

MR. W. O. HOLLISTER: Would you use the dormant oil?

MR. J. G. SANDERS: Only for the scale, not for the mite.

MR. S. C. CHANDLER: Do you recommend fall spraying and spring spraying?

MR. J. G. SANDERS: As I noted in the paper, Professor Garman and Professor Bourne have shown that the longer treatment could be delayed in the spring, in the late dormant period, the better the control was. With two or three petroleum sprays they raised their percentage of kill from about 85 to 99 within six weeks in the spring.

FIRST VICE-PRESIDENT W. P. FLINT: The next paper is by S. C. Chandler.

CODLING MOTH HIBERNATION STUDIES[1]

By S. C. CHANDLER, *Illinois State Natural History Survey*

ABSTRACT

Examinations of Codling Moth (*Carpocapsa pomonella*) larvae hibernating on trunks of trees showed 30% of the larvae at or just below the ground line. On the ground between the trees eight times as many larvae were found in artificial situatinos as in natural cover. Pieces of bark were the only type of natural cover in which larvae on the ground were found. In preliminary tests with emulsions of fish oil soap and of orthodichlorobenzene no penetration of the hibernaculae was effected.

During periods of severe Codling Moth infestation, such as the season of 1926, the practices of banding and of maintaining orchard sanitation become of importance, and are often recommended. How much benefit can be derived from these practices, however, has been a question in the minds of both growers and experimentors. If it could be established what proportion of the larvae winter on the trunk of the tree, a more accurate statement of the importance of fall banding could be made. If it could be ascertained what types of cover are preferred by larvae hibernating between the trees we would have a clearer notion of what sort of cleanup measures to stress. It was with these ideas in mind that hibernation studies were undertaken in the winter of 1926–27 in the Ozark section of southern Illinois.

HIBERNATION ON TREES

After studying the location of the hibernating larvae on the apple trees in the orchard for a short time, it became evident that a considerable proportion of them were at or below the ground line. To get data on this point a number of orchards which had had a heavy infestation were examined. None of the trees had been scraped or banded. They were gone over thoroughly, starting with the main crotch and including it, and working down to an inch below the surface. From one-half to three-quarters of an hour was spent on each tree. Records were made of the number of larvae found from the crotch to within an inch of the ground, and also of those found from that point to an inch below the surface. The data are summarized in Table 1.

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[1] Contribution from Project 9.1, Illinois Natural History Survey.

TABLE 1. HIBERNATION ON TRUNK OF APPLE TREES

Number of Trees Examined	Number Orchards Represented	Total Larvae Up	Total Larvae Down	Grand Total	% Down
28	10	94	42	136	30

The relatively small numbers of larvae found in these heavily infested orchards may be explained by the feeding of birds. High mortality from birds has been noted by many others who have studied Codling Moth hibernation. In the orchards of southern Illinois I found that fully 90% of the larvae had been removed by their bird enemies. Were it not for the birds the number recorded above as found at or below the ground line would have represented a considerably smaller proportion of the total, as larvae are much safer in such situations.

To learn whether the numbers found at the bases of trees which had been scraped and banded differed materially from the above, forty such trees were examined. Twenty-five larvae were found at or below the ground line, or 6 worms per tree, as compared with 1.5 in the unbanded trees. It was observed that there were fewer larvae at the bases of banded trees which had been scraped down to the ground. The tendency is to leave at least an inch of rough bark at the base untouched.

HIBERNATION BETWEEN TREES

To determine the extent of hibernation in the orchard aside from the trees themselves, ground strips were examined, 3 feet in width running from the base of one tree to the base of another. These strips were located in the same heavily infested orchards, and in most cases began at the bases of the same trees examined for the above records. For this reason it would be fair to compare the numbers recorded as found on the trees with those found on the ground. Most of these orchards had received little or no cultivation, and there was plenty of natural cover, consisting of bluegrass sod, weeds, dead leaves, twigs and bits of dead bark. These strips were gone over inch by inch, requiring about an hour for each one. In all 23 of them were examined. The results are shown in Table 2. They give some information on the following points:

1. EXTENT OF HIBERNATION BETWEEN TREES. It will be observed that in 13, or over half of the strips no larvae were found. While it is true that the strips were only 3 ft. wide, they were located in the tree rows, which usually contains more cover than the middles, and as they extended up to the trunk of the tree, they usually took in about half the rough bark that had sloughed off from the trunk.

2. HIBERNATION IN NATURAL COVER. The only natural cover selected by the larvae was bark, notwithstanding the fact that most of the ground cover consisted of other things such as grass and dead leaves.

TABLE 2. HIBERNATION OF CODLING MOTH LARVAE IN GROUND STRIPS

Strip No.	Larvae Found in Natural Cover		Larvae Found in Artificial Cover	
1	0		0	
2	0		0	
3	0		0	
4	0		4	old pair of pants
5	1	Bark of dead branch	0	
6	0		0	
7	1	Between 2 pieces of bark on ground	0	
8	0		0	
9	0		0	
10	0		0	
11	0		0	
12	0		0	
13	0		59	Nitrate sack Mouse poison station
14	0		15	Nitrate sack Mouse poison station Rotted piece of timber
15	4	Bark of uncovered part of main root	13	Mouse poison station
16	0		0	
17	0		4	Old rail Bark on Prop pole.
18	0		1	Old piece of board
19	1	Bark of dead branch	0	
20	0		0	
21	0		0	
22	0		0	
23	5	Piece of bark	2	Piece of basket Old shirt
Total	12		98	

3. HIBERNATION IN ARTIFICIAL COVER. It will be observed that about the same number of strips contained larvae in natural cover as did in artificial cover, but over eight times as many larvae were found in the man made hiding places as in the natural cover of the orchard. Had all the orchards contained artificial cover a still greater contrast would have been presented. As it was, about half the strips contained little or none of this type. These data cannot fail to emphasize the importance of keeping the orchards clear of all kinds of trash.

CONTROL EXPERIMENTS

Preparatory to orchard experiments for the destruction of hibernating Codling Moth Larvae, tests were conducted to determine the possibility of killing larvae in their hibernaculae. Strips of corrugated cardboard in which hibernating larvae had cocooned were soaked and the cardboard removed, leaving only the cocoons for protection. They were then subjected to different strengths of boiled fish oil soap emulsion and an emulsion of orthodichlorobenzene. They were examined in from 7 to 12 days in a warm room. Table 3 summarizes these tests.

TABLE 3. TESTS FOR CONTROL OF HIBERNATING CODLING MOTH LARVAE

Treatment	No. Tests	Larvae Examined	Larvae Dead
Fish Oil Soap Emulsion			
2%	1	90	2
8%	2	200	4
25%	1	100	2
O. D. B. Emulsion			
2%	1	45	1
8%	1	54	0
Checks	3	250	2

These preliminary tests, as may be seen by the table, were so emphatically negative that no further attempts with these materials were made.

MR. J. J. DAVIS: I should like to say that in Indiana we find the cornstalks and bits of wood, other than bark, very important carriers of the codling moth. I would like to ask Mr. Chandler when he made his examination of the trunk and also his examinations of the strips.

MR. S. C. CHANDLER: These were made in January and February.

FIRST VICE-PRESIDENT W. P. FLINT: The next paper is by C. H. Alden and M. S. Yeomans.

CODLING MOTH CONTROL IN GEORGIA APPLE ORCHARDS

By C. H. ALDEN and M. S. YEOMANS, *Georgia State Board of Entomology*

ABSTRACT

Codling moth (*Carpocapsa pomonella*) control work in Georgia in 1927 consisted of (1) Insectary work from which the number of broods and peaks were obtained which gave a correlation between insect development and spraying dates so that the proper time for the various applications could be given to the grower. (2) Field experiments on spraying, dusting, banding and scoring of fruit to obtain the best control measures for this section. (3) Insecticidal analyses of fruit sprayed with arsenate of lead. (4) Additional control measures used to supplement the regular ones were scraping of trunk, general orchard banding by growers, thinning of fruit and orchard and packing house sanitation.

INTRODUCTION

The codling moth, *Carpocapsa pomonella* Linn., is the most serious insect infesting Georgia apple orchards and for the past five years has caused very serious losses to the growers. In 1926, as high as 75% of the apples were wormy at harvest time. In 1927, a very vigorous campaign was waged against this insect and by closely following its life history, it was possible to improve the spray schedule and other control measures so that a marked reduction in the number of infested apples at harvest, was obtained as compared to the 1926 season. As low as 2% of the fruit was found wormy in the best experimental plat used and general commercial orchard infestations were way below the previous year.

INSECTARY WORK

Overwintering larvae were brought in from the orchards and the dates of first pupation and emergence of spring brood moths were obtained both in the insectary and by means of field cages in the orchard. These dates corresponded very closely so that the peaks of egg deposition in the insectary could be used as a guide for the proper times to spray.

With the exception of the first application, which was to fill the clayx cups with poison, in advance of emergence, all applications put on by growers were applied at the peaks of egg deposition as determined by the insectary records of codling moth development.

In 1927 there were three broods and a partial fourth. The only previous available records made by Van Leeuwen[1] gave three broods in 1920 and four in 1921. As the peaks of egg deposition of the various broods were reached, circular letters were sent out to the growers and newspapers in the apple belt, advising them when to spray and what to use. The spring brood was very large, as was the first brood, although the first brood moths laid more eggs per female than the spring brood. The following broods were smaller, many of the third and all of the fourth brood larvae going into hibernation. A few of the first and second brood larvae also went into hibernation. Such information must be taken each year for the best control to be obtained from spraying. If the sprays are put on too early, much of the spray material washes off and the apples increase in size so that they do not have a proper coverage when the tiny worms hatch; if it is put on too late, the worms have entered the apples before the poison is applied, making such applications nearly worthless. The sprays must be put on at exactly the right time to obtain efficient results.

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[1] E. R. Van Leeuwen, Bureau of Entomology, U. S. D. A. unpublished record.

Weather records, including both temperature and humidity, were taken hourly with a hygrothermograph in conjunction with the life history studies made in the insectary. The maximum and minimum temperatures and daily rainfall were also recorded with U. S. Weather Bureau instruments. As a whole, the weather was favorable toward the development of the codling moth, there being a marked deficiency of rainfall, a condition that generally means wormy fruit in the Georgia apple belt. It was found that the codling moth would not deposit eggs when the night temperatures fell below 60 degrees F. and deposited sparsely when the day temperatures reached a maximum of 90 degrees F. or above. The total amount of rainfall from April to September, which was the period of activity of the codling moth, was only 15.19 inches, which is 9.73 inches below the normal precipitation. The humidity for the period ranged from a maximum of 96 to a minimum of 21. As a whole, the humidity was moderate during the day and high at night.

FIELD EXPERIMENTS,—SPRAYING AND DUSTING

The field experiments consisted of spraying, dusting and banding. The following new spray materials were used: Scorodite, Magnesium arsenate, Tricalcium arsenate, Manganese arsenate, Aluminum arsenate and Zinc arsenate. These were used in the hope that a substitue for lead arsenate would be found, as lead arsenate has been objected to by the pure food authorities who claim that at times an excessive amount of lead arsenate is left on the fruit. All of these materials gave poor results in controlling the codling moth as compared with lead arsenate and in addition most of them burned the foliage severely.

Besides these new chemicals and lead arsenate, dusts, oils and calcium arsenate were used. The best fruit was obtained from those plats treated with lead arsenate, lime sulphur and Bordeaux mixture. Most varieties required six applications of lead arsenate and a fungicide during the 1927 season to give good fruit at harvest time.

The table on the following page gives a summary of the results obtained in spraying and dusting experiments for 1927.

This table shows that the plats sprayed with lead arsenate gave the best control of the codling moth, having nearly 98% sound fruit at harvest. The best dusted plat had about 80% sound fruit and the plat sprayed with oil emulsion had over 90% sound fruit. Of the new arsenicals tested, Magnesium arsenate gave the best results, having 73% sound fruit at harvest. The checks, or untreated trees, had 42% sound fruit at harvest and the yield was very small.

Commercial results were taken from two different orchards where the state schedule was followed, with the following results on the codling moth, considering stung fruit as sound; 87% sound and 89.2% sound. The previous year one of these orchards had nearly all the fruit wormy and the other had about 75% wormy at harvest.

Samples of fruit were taken by the state and federal chemists in the north Georgia apple belt during the months of August and September. Where the state schedule was followed, the arsenical content per pound of fruit was .028 to .035 grains before wiping or brushing; after cleaning it ranged from .002 to .010 grains. Where additional applications were made, in some cases as high as nine, compared to the six recommended, as high as .023 grains per pound of fruit was found which is considerable above the International Tolerance Standard of .01 grains per pound of fruit. All analyses made were from fruit where arsenate of lead in the form of a liquid spray was used.

FIELD EXPERIMENTS—BANDING

Sixteen kinds of banding experiments were run in the experimental orchard and of all the types used, a band chemically treated with Beta-naphthol and cylinder oil,[2] seems to give the most promise of success. This band consisted of a strip of unbleached sheeting, 4 inches wide and of 3 thicknesses. The side that was placed next to the tree was treated with Beta-naphthol and refuse cylinder oil in the proportion of 1 pound

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[2] Chemical Treatment of Bands as a Supplemental Control Measure for the Codling Moth by E. H. Seigler Assoc. Ent.; Luther Brown, Asst. Ent.; E. J. Newcomer, Assoc. Ent., U. S. Bureau of Ent., from Jour. Ec. Ent., Vol. 20, No. 5, pp. 699–701.

TABLE 1. SUMMARY OF RESULTS, CODLING MOTH, CORNELIA, GEORGIA, 1927

Plat	Treatment	Total No. of Apples Examined	Total No. of Worms (Including Extra)	% of all Apples Free from Worms	% Harvested Apples Free from Worms
1	Lead arsenate, 1 lb., water 50 gals.	10750	516	95.3	98.0
2	Lead arsenate 1½ lbs., water 50 gals.	9166	250	97.3	97.7
3	Calcium arsenate ¾ lb., water 50 gals.	10680	4802	63.2	44.8
4	1st appl. same as No. 1. 5 following 80% sulphur, 10% lead, 10% lime	10494	4415	63.1	74.0
5	80% sulphur, 10% lead arsenate, 10% hydrated lime	12523	2049	85.7	79.0
6	70% sulphur, 15% lead arsenate, 15% inert	5071	1918	66.9	73.8
7	1st appl.. same as No. 1; following 5, 1 lb. lead arsenate, ½ gal. white oil, ¼ lb. cal. caseinate, 50 gals. water	10950	1617	85.9	92.6
8	Same as 7 except 1½ lb. lead arsenate to 50 gals. water	12262	2634	81.0	84.9
9	Same as No. 1, but with only 1 nozzle per rod	11108	2078	83.6	78.7
10	Check, untreated	2367	1614	39.7	41.9
11	Scorodite, 1 lb., water 50 gals.	447	245	55.7	60.1
12	Tricalcium arsenate, 1 lb., water 50 gals.	474	304	53.8	31.6
13	Aluminum arsenate, ¾ lb. lime 3 lbs., water 50 gals.	719	621	46.3	50.9
14	Zinc arsenate, ¾ lb., water 50 gals.	461	166	70.0	43.4
15	Magnesium arsenate 1 lb., water 50 gals.	1181	358	76.1	73.1
16	Manganese arsenate 1 lb., water 50 gals.	1253	196	87.2	25.0

NOTE: The fungicides used were as follows: the first 2 applications were lime sulphur 5 qts. to 50 gals. of water; the next 4 Bordeaux mixture, either 3-3-50 or 4-4-50 depending on the susceptibility of the varieties sprayed. The fungicide used in the dust was sulphur either 70% or 80%. Plats 11 to 16 received wettable sulphur 4 lbs. to 50 gals. of water. A sticker was used in all dust materials applied.

of Beta-naphthol to 1 quart of oil and applied with a paint brush. Before placing the band in position, the trunk was scraped. A good heavy coat of the material was laid on to the sheeting and then wound around the trunk about 1 ft. from the ground and fastened with a tack.

These bands were placed in position May 16th and never retreated throughout the season. Sixty-three trees were so treated and a few trees were examined from this plat at 10 day intervals. Up to September 12th, 61 trees were examined with the following results; 1356 larvae and 2 pupae dead; and 95 larvae and 5 pupae alive. Of those found alive, many had just gone under the bands and were killed after a longer exposure.

The actual percentage found dead was 92.5 altho no empty pupal cases, indicating moth emergence, were ever found which would indicate that the actual percentage killed was higher than noted. Under untreated burlap bands, examined at the same intervals as the Beta-naphthol bands, 106 empty pupal cases were found.

Cost factors have not been definitely established but for this year the Beta-naphthol and oil band cost about 2 cents per tree. Other materials and the labor of applying are about the same as putting on an ordinary untreated burlap band. The untreated bands must be removed every 10 days and the larvae and pupae killed by hand. The Beta-naphthol band will remain effective for at least 4 months and possibly the whole season without further attention altho a second treatment during the year would increase the efficiency. The labor cost is way below that of the regular bands of burlap, now in use in the apple belt.

Regular observations were made on the effect of the Beta-naphthol—oil bands on the trees and aside from a little discoloration of the outer bark layers, no injury was found. It is planned to continue these experiments over a period of years to determine the cumulative effect, if any.

Additional Control Measures

Other control measures used against the codling moth were scraping the tree trunks in the early spring before moth emergence and burning the scrapings; general orchard banding by growers; clean cultivation and turning under the trash and other hiding places for the codling moth larvae throughout the season; thinning of fruit so that a better spray coverage could be obtained and cleaning up in and around the packing shed.

SUMMARY

There were 3 broods and a partial fourth of the codling moth during the 1927 season.

Six sprays, all containing lead arsenate, were recommended to the growers.

Analyses of fruit showed that the arsenical content of fruit sprayed with arsenate of lead in liquid form by the state schedule was within the International Tolerance Standard of .01 grain per pound of fruit.

All spray dates, except the first, which was to fill the calyx cups with poison, were recommended from information obtained on the development of the codling moth in the insectary.

The experimental plats giving the best results at harvest were those sprayed with either a pound or 1½ pounds of lead arsenate to 50 gallons of water with a fungicide added to all sprays for the additional control of scab and bitter rot.

New chemicals tested gave poor results as compared with lead arsenate and caused foliage injury. Magnesium arsenate gave the best results in controlling the codling moth, of all the new chemicals used.

Lead arsenate dusts were inferior to lead arsenate sprays in the control of the codling moth.

The best band for the control of the codling moth was one of unbleached sheeting 4 inches wide and of 3 thicknesses treated with Beta-naphthol and oil in the proportion of 1 pound of Beta-naphthol to 1 quart of oil.

Other control measures used were scraping, general orchard banding, thinning and orchard and packing house sanitation.

The infestation in commercial orchards was reduced from an average of 60% in 1926 to about 12% in 1927.

FIRST VICE-PRESIDENT W. P. FLINT: The next paper is by W. S. Hough.

RELATIVE RESISTANCE TO ARSENICAL POISONING OF TWO CODLING MOTH STRAINS

By WALTER S. HOUGH, *Winchester Research Laboratory of the Virginia Agric. Exp. Station*

ABSTRACT

Codling moth (*Carpocapsa pomonella*) larvae from the Grand Valley of Colorado and the Shenandoah Valley of Virginia were reared at Winchester, Virginia for the purpose of comparing their ability to enter sprayed fruit. Lead arsenate was used at the rate of four pounds in one hundred gallons of water. The Colorado larvae demonstrated a marked superiority over the Virginia larvae in their capacity to enter the sprayed apples. The strains were crossed and the first generation of each cross was less resistant to arsenical poison than the pure strain of Colorado larvae but more resistant than the Virginia larvae.

Not so many years ago one spray placed in the calyx cups of apples was considered sufficient for control of the codling moth. Now the number of sprays advised varies widely in different orchard sections. This is even true for sections in which the seasonal history of the insect is similar, having the same number of generations and apparently developing at the same time.

Differences obtained in control have usually been attributed to the effect of climatic factors, to parasites and the number of broods of larvae.

According to published data[1] the seasonal history of the codling moth in the Grand Valley of Colorado and the Shenandoah Valley of Virginia is about the same. Even the time of deposition of the different broods of eggs appears to be nearly the same. In the former section a minimum of seven and eight sprays is recommended. In Virginia three and four sprays give excellent control.

SOURCE OF MATERIAL. Through the courtesy of Prof. George M. List of the Colorado Experiment Station a shipment of codling moth larvae was received from Grand Junction, Colorado on April 6. The larvae were collected from bands on pear trees by Otto M. Forry, Horticulturist of Mesa County.

The Virginia larvae passed the winter of 1926-27 in pupation strips exposed to outdoor temperatures at the Winchester insectary. The larvae were from life history material reared at the insectary and from bands in two orchards at Winchester. One of these orchards is on the property of the Shenandoah Vinegar Company and each year it receives a heavy infestation of moths which fly from the bins of the vinegar company. Each fall the bins are filled with cull apples from all parts of Frederick and Clarke counties.

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[1] U. S. Dept. of Agric. Bulletin 932, Colo. Agric. Exp. Sta. Bulletin 322, Va. Agric. Exp. Sta. Bulletin 248.

METHOD. For tests with the first brood of larvae, apples, three-fourths to one inch in diamater, were selected from one tree of an unknown variety which had received a very light calyx spray. For the other tests York Imperial apples were picked from two trees which were not sprayed at any time during the season. The apples selected were from one and a half to two and a half inches in diameter.

The apples were picked, suspended and sprayed before the eggs were placed on the fruit. Lead arsenate was applied at the rate of four pounds in 100 gallons of water. A Myers hand sprayer was used. Every effort was made to spray the apples thoroughly and as nearly alike as possible. In case of the last experiment a second but less drenching spray was applied as soon as the first application had dried.

As soon as the spray had dried a pear leaf or part of a leaf, containing the desired number of eggs, was attached by means of a paper clip to the string suspending each apple. In each instance the pear leaf or paper clip rested on the side of the apple. Four eggs in the first experiment and five eggs in the second and third experiments were placed on each apple. One hundred apples were used for each strain or cross in each experiment except in the case of the checks of the second and third experiments. For these checks twenty apples each were used. Slightly less than a normal hatch occurred because a few eggs were injured in making the attachment to the fruit.

Eggs were used which hatched in one to three days after the fruit was sprayed and suspended. About one week after the eggs hatched the final examination of the apples began. Before cutting open an apple a record was made of the number of dead larvae still adhering to the side of the fruit. This count was incomplete and cannot be considered comparable for the various strains, because all of the apples could not be examined on the same day. Apples examined last had the least number of dead larvae adhering to the sides. No attempt was made to recover dead larvae from the calyx end.

The fruit was sprayed and the eggs were attached on June 7, July 26 and August 10.

DISCUSSION. A summary showing the percentage of worms which entered the apples and remained alive is given in Table 1. Table 2 shows the percentage of total side injuries including stings, which were conspicuous enough to be observed by the unaided eye.

CALYX WORMS IN THE CHECK APPLES:—No attempt was made to prevent the larvae from entering the calyx end of any of the apples, sprayed or unsprayed. It will be observed that calyx worms in the check apples were about one-fourth as numerous as side worms in the first experiment and about one-third as numerous in the second and third experiments. The increase in the proportion of the calyx worms among the second brood larvae was probably due, in part, to the variety of apple used and also to the fact that the York Imperial apples had not been sprayed prior to the experiment in which they were used. It will be recalled the unknown variety on which the first brood larvae fed received a very light calyx spray, which was applied about five weeks prior to the time of the first experiment.

There were two kinds of calyx entrances. One through the calyx lobes with no evidence of eating on the outside of the cup. In the second type the larva ate into the upper or more frequently the lower cup from the outside, usually near the base of the calyx lobes.

CALYX WORMS IN THE SPRAYED APPLES:—Attention is called to the fact that a spray applied long after the calyx cups closed reduced the number of calyx worms (Virginia strain) to less than one-third of the number found in the checks. Colorado larvae entered through the calyx end with considerable success. More than two times as many were successful as the Virginia larvae.

It seems that many of the larvae picked up poison before reaching the inside of the blossom end and later died in the cup. Often, however, the larva lived long enough to make a minute sting at the bottom of the lower cup.

SIDE WORMS:—Although the apples were sprayed as nearly alike as the eye could detect, the Colorado larvae consistently demonstrated their superiority over the Virginia larvae in their ability to penetrate the side of the fruit. It was difficult to believe that some of the larvae of the Colorado strain could remain alive and healthy after entering through or at the margin of spots of dried spray material. The stings made by the unsuccessful Colorado larvae outnumbered the stings made by the Virginia larvae and were usually more conspicuous.

As a first step in answer to the question of the cause of the marked difference shown by the two strains, crosses were obtained by mating the first brood of moths reared in the insectary. Colorado males with Virginia females and Colorado females with Virginia males were mated. The F_1 generation of the crosses was more capable of penetrating the side of the sprayed fruit than the Virginia strain, but seemed to have lost much of the potency exhibited by the pure strain of Colorado larvae.

Differences in The Strains. The writer knows of no physicial differences in the larvae. No difference has been observed in their habits. In comparing a series of individuals a number of the Colorado moths appeared lighter in color than the Virginia moths. This might be due to the influence of the drier western atmosphere. The Colorado females were not more productive than the Virginia females. In fact, the average number of eggs deposited by the spring brood of moths as well as the first brood of moths of the latter strain was somewhat greater than the respective averages established by the Colorado strain. At the same time Colorado females mated with Virginia males averaged 143 eggs and Virginia females mated with Colorado males averaged 122 eggs per female.

Remarks

The superiority of Colorado codling moth larvae over Virginia larvae in penetrating the side of sprayed apples was demonstrated in three successive tests.

The F_1 generation of both crosses was somewhat more capable of entering sprayed fruit than the Virginia larvae but much less resistant to control by arsenical spraying than the pure strain of Colorado larvae.

Table 1.

Exp. No.	Strain	No. of Eggs Hatched	Live Larvae Entering Side Per cent	Calyx End Per cent	Total Per cent
1	First brood larvae				
	Virginia	360	.5	3.8	4.3
	Colorado	365	25.2	6.3	31.5
	Virginia (check)	366	46.1	11.7	57.8
2	Second brood larvae				
	Virginia	465	1.9	4.7	6.6
	Colorado	452	29.2	10.1	39.3
	Colorado ♂ Virginia ♀	467	10.4	3.4	13.8
	Colorado ♀ Virginia ♂	455	14.5	5.9	20.4
	Virginia (check)	179	58.1	16.7	74.8
3	Second brood larvae				
	Virginia	457	2.6	2.1	4.7
	Colorado	472	29.0	8.6	37.6
	Colorado ♂ Virginia ♀	468	5.1	5.5	10.6
	Colorado ♀ Virginia ♂	434	5.9	7.3	13.2
	Virginia (check)	180	49.4	16.1	65.5

Further investigation is necessary to shed light on the nature and cause of the difference demonstrated by the two strains in their resistance to arsenical poisoning.

TABLE 2

Exp. No.	Strain	No. of Eggs Hatched	Entrances, Per cent	Side Stings, Per cent	Total Side Injuries, Per cent
1	First brood larvae				
	Virginia	360	.5	10.5	11.0
	Colorado	365	25.2	20.5	45.7
	Virginia (check)	366	46.1	2.7	48.8
2	Second brood larvae				
	Virginia	465	1.9	12.2	14.1
	Colorado	452	29.2	15.0	44.2
	Colorado ♂ Virginia ♀	467	10.4	12 6	23.0
	Colorado ♀ Virginia ♂	455	14.5	20.2	34.7
	Virginia (check)	179	58.1	0	58.1
3	Second brood larvae				
	Virginia	457	2.6	7.0	9.6
	Colorado	472	29.0	10.3	39.3
	Colorado ♂ Virginia ♀	468	5.1	6.4	11.5
	Colorado ♀ Virginia ♂	434	5.9	6.6	12.5
	Virginia (check)	180	49.4	1.1	50.5

MR. L. HASEMAN: I should like to ask the speaker if he ran feeding tests so he knew how much poison one strain could stand as compared with the other.

MR. W. S. HOUGH: I did not.

MR. B. A. PORTER: I should like to know how many worms he used in the test.

MR. W. S. HOUGH: The total exceeded 4,800. In no case, in any one strain, was there less than 360 larvae, which could attack the sprayed fruit.

MR. B. A. PORTER: I wanted him to add that additional weight on the work he has done, because the large number of worms is much more likely to be more significant than a smaller number.

FIRST VICE-PRESIDENT W. P. FLINT: The next paper is by W. S. Regan and A. B. Davenport.

SOME RESULTS OF THREE YEARS' EXPERIENCE SEEKING BETTER CONTROL MEASURES FOR THE CODLING MOTH IN THE YAKIMA VALLEY, WASH.

By W. S. Regan and A. B. Davenport, *California Spray Chemical Co., Yakima, Wash.*

Abstract

The addition of oil spray to arsenate of lead offers a material aid in Codling Moth (*Carpocapsa pomonella*) control. Five different types of oil have been tested. The factors of refinement, volatility, oil penetration, emulsification, residue removal, etc., are discussed. Some results of tests and practical orchard experience are given in controlling Codling Moth on apples and pears, with the lead-oil combination and with oil spray alone.

Better Control Measures Desired

Many orchardists in the Yakima and Wenatchee districts, as well as in other fruit sections of the Northwest, have for some years past found it necessary to make from six to ten or more applications of Arsenate of lead each year in order to secure even fair control of the Codling Moth. After admission is made that lack of satisfactory results may be due in some measure to careless application and insufficeint attention to proper "orchard sanitation" or supplementary control measures, the fact still remains that many good growers, with years of experience, after having made of themselves virtual slaves to the "spray rig," from May 'til September, still have to take at harvest time a cullage of from ten to thirty per cent or more, because of worms and "stings" by this pest. Large acreage and insufficient or poor equipment, delays because of windy conditions, interference from irrigation requirements and similar considerations, all are factors contributing towards this unfortunate condition. Nevertheless, in spite of all possible allowance, it can be stated with certainty that the majority of growers of the Northwest have not found in Arsenate of lead the measure of control to which they might be considered justly entitled, in view of the time, labor and expense involved.

The need of an insecticide with more "kick" than Arsenate of lead, or at least something to increase the effectiveness of this Arsenical, has long been expressed by those who have had to face this problem. This desire has been all the more in evidence during the past two years, since the spray residue restrictions have been put into force, because of the fact that the frequent and numerous applications needed in many cases for satisfactory control have greatly increased the difficulty of residue removal to the tolerance required.

OIL SPRAY AS A POSSIBLE CONTROL AID

During the past three years orchard tests have been conducted in the Yakima valley to determine to what extent oil spray might be used as an aid in Codling Moth control. It has been definitely determined by numerous investigators that oil sprays are highly effective in destroying the eggs of the Codling Moth before they hatch, thus offering a more logical method of attack than that by which the young worms are killed in the actual process of feeding and injuring the fruit. The fact, furthermore, that oils have a wide range of efficiency in destroying other prevalent orchard pests, such as San Jose scale, Red Spider, Aphis, Leafhopper, etc., all of which are of serious economic importance in Northwest fruit sections, places oil spray in a special position of favor, as entitled to full and fair consideration in this connection.

It was evident at the outset of these investigations that there were a number of factors limiting the use of oil sprays on orchard trees. Chief among these, in addition to actual efficiency, were margin of safety, to trees, foliage and fruit, and cost for results obtained, that is, whether the added expense per tank was justified by a lower labor cost for fewer applications or by sufficiently better control.

During 1925 little was determined other than that a highly refined summer or foliage oil, used in connection with Arsenate of lead, did give far better Codling Moth control than that obtained in a block of trees in the same orchard, sprayed with Arsenate of lead alone. In 1926 a large series of tests were carried out on Winesap apples to determine the comparative effectiveness of (1) Arsenate of lead alone, (2) Arsenate of lead with caseinate spreader, (3) Arsenate of lead in combination with oil spray, and (4) oil spray alone. In these tests two different oils were used; one of high refinement and low volatility and another of moderately high refinement and volatility. In general the Lead-oil combination showed far better control then either the lead alone or lead-spreader combination, there being from three to four times the number of culls, on the average, for the blocks where no oil spray was used in combination with the lead for an equal number of applications. Oil spray alone, in several tests, gave fair results but not such as would justify the conclusion that the average grower at present would secure satisfactory results in the control of Codling Moth with oil spray alone. Furthermore, the apparent necessity of making frequent or heavy application with oil spray in badly infested districts, where this insecticide was to be depended upon alone for control, introduced factors which clearly indicated a need for much more investigation. (See "Results of Different

Insecticide Treatments on the Control of Codling Moth in the Pacific Northwest," by W. S. Regan, issued by the California Spray-Chemical Co., Watsonville, Cal., 1927.)

SCOPE OF 1927 TESTS

In addition to Winesaps, Romes and Jonathan apples, Bartlett, Bosc, D'Anjou, and Nellis pears were included in this year's tests. Five different oil emulsions were tested. These contained 83 per cent actual oil and varied from 62 to 100 per cent saturation (refined), and from 50 to 107 seconds viscosity. The retail cost of the oil emulsions used ranged from thirty cents for the less refined oils to one dollar per gallon for the heavy, highly refined oils, with intermediate prices for the oils of moderately high refinement or greater volatility. There were a total of fourteen tests, all of which were carried out under practical orchard conditions. With the exception of four tests, all of these consisted of the lead-oil combination. Of these four, one test, on Romes, consisted of Arsenate of lead with spreader and three with oil spray alone, without any arsenate of lead; two in the case of pears and one on Winesaps. The pears received a total of three applications and the apples four, except in two tests, where five applications were made with the lead-spreader combination on Romes and five with oil spray alone on Winesaps. It should be noted that it is the common practice in the district where these tests were carried out to spray pears four or more times and apples six or more times with Arsenate of lead.

The different oil emulsions were tested at 1, 1½ and 2 per cent of the 83 per cent oil emulsion. In general every one of the five oil emulsions tested showed good ovicidal action at as low as 1 gallon in 100, and even the poorest results with the lead-oil combination were better than where the Arsenate of lead was used without oil. There are, however, limiting factors in the use of various types of oils, as indicated by these test. Some of these features will be discussed further but owing to lack of space no attempt will be made to present tables or to enter into a detailed discussion of these results in this paper.

IMPORTANT FACTORS IN THE USE OF SUMMER OR FOLIAGE OIL SPRAYS

REFINEMENT AND VOLATILITY. Two of the most important characteristics of a summer or foliage oil spray, as shown by these tests, are refinement and volatility. With reasonable refinement volatility is the more important factor of the two; for an oil that is too slowly volatile, and used too heavily, permits penetration, may cause interference with the natural functioning of the plant, and give rise to such important disturbances as discolored fruit, undersized fruit, and even reduced bud formation and fruit set for the succeeding year.

Well refined oils (85 per cent and preferably higher) of moderate or fairly high volatility are to be preferred to oils of lower refinement or of too low volatility, or even, in some instances, to a highly refined oil of low volatility. This appears to be true from the standpoint of both control and ultimate effect upon trees or fruits. Oils of lower refinement can never be used on foliage and fruit without considerable hazard. Even when this hazard is avoided, by good fortune or otherwise, foliage stunting is almost certain to result from any continued use of oils of comparatively low refinement. On the other hand, oils of high refinement, when used in moderation, appear to have a stimulating effect upon foliage, but to what this stimulation is due yet remains obscure. Lighter oils have quicker spreading property and quicker, though not persisting penetration. Better results than have been secured with lighter oils in some of our tests may possibly be accounted for by this better spreading property, and accordingly a more thorough application and contact, which results with the lighter types of oil. Where summer control of scale is involved, our experience would indicate that oils of too great volatility are likely not to give the penetration needed for effective kill, especially where incrusted scale occurs. Manufacturers are recognizing the need for oil sprays of different degrees of volatility, as indicated by the designation of "light," "medium," and "heavy" oils. The lighter types of oils have another advantage, from a physiological standpoint, in that the oil film disappears rapidly after application and is completely gone in a matter of hours, whereas the heavier, less volatile oils may persist for from several days to several weeks, according to the strength used and the thoroughness of application.

OIL PENETRATION. The importance of oil penetration, from the standpoint of undesirable physiological effects upon orchard trees and fruit, has already been mentioned. Many of the difficulties met with in the use of oil sprays are due to this one factor. The degree or extent of oil penetration is closely associated with tree condition and the volatility of the oil used. Trees in unthrifty condition or weakened from any cause, permit greater oil penetration, especially where the heavy, slowly volatile oils are used, and corresponding ill effects.

Reference has been made to some of the undesirable reactions which sometimes accompany the use of certain types of summer oil, such as inferior sizing of fruit, retarded coloring, fruit discoloration, etc. It should not be concluded that these reactions always accompany the use of oil sprays. Tree condition, climatic factors of excessive heat and drought, and type of oil used are all determining factors in tree or fruit reaction. Among the thirteen tests carried out this year with oil sprays on apples and pears, there was only a single test where any ill effects were noticeable. This was where five unusually thorough applications were made to winesaps, with a heavy, slowly volatile oil, at 1½ gallons in 100. Here there was evident retarded sizing and possibly slower coloring of the apples. Pears, on the whole, appear to show less reaction to heavier oil applications than apples, but even here there are reasonable limitations. It is interesting to note that Jonathans, in the display that won first prize at the Washington State Fair, had been sprayed four times with one of the heavier summer oils, and that Newtowns and Spitzenbergs that took first prize at the Pacific Northwest Exposition at Portland, Oregon, had been sprayed four times with a lighter type summer oil.

One of the stumbling blocks in the use of summer oils has been fruit discoloration, especially about the calyx end, due to oil penetration, on such varieties as Newtown and Ben Davis and occasionally on certain other varieties. Observations this year indicate that this difficulty can be almost entirely overcome by the use of oils of high refinement and volatility.

EMULSIFICATION. Although the idea appears to be entertained by some, that all there is to the preparation or manufacture of an oil spray is the agitation of an oil with an emulsifying agent, emulsification, in fact, is one of the most complex and technical phases of the production of safe and effective oil sprays. The amount and kind of emulsifier is, in a large measure, the determining factor. The emulsifier can be used so that a minimum amount of oil will give desired results, or it may be so used that practically double the amount of oil is required, because much of the oil is actually lost from the tree in the drip. The difference in the method of emulsification is frequently the cause for variable results with the same percentage of any particular oil. Emulsification can be made also to exert another influence of a beneficial nature, by inhibiting oil penetration of foliage, fruit, or bark, and by keeping the oil film upon the surface, thus make effective far weaker applications than those ordinarily required.

OIL SPRAY AND SPRAY RESIDUE REMOVAL

Another consideration in the use of oil spray is the effect that it may have upon spray residue removal, when summer oil is combined with arsenate of lead or follows it. In general, investigation has shown that, properly handled, oil spray does not retard spray residue removal by machine wiping, to the extent ordinarily possible with such equipment. Individual cases of course can be cited in which great difficulty was experienced where oil spray had been used. The same can be said also in certain cases where no oil was applied. When arsenate of lead and oil spray are combined, spreader of the right type and in proper amount should be added to prevent curdling and consequent blotching of the lead. Blotched lead, from whatever cause, increases the difficulty of spray residue removal. Among some of the factors that interfere with the cleaning process by machine wiping, where oil spray has been applied, the following might be mentioned— (1) the use of certain types of spreader, which blotch the lead, when lead and oil are combined, (2) the use of oil and lead in the tank without spreader, (3) the application of oil over heavily blotched lead, (4) the use of inferior grade oil which may cause russeting or spotting of the fruit, thus "setting" the lead into the skin in these spots, and (5) the use of a heavy oil close to picking, allowing insufficient time for the oil to volatilize before wiping is attempted.

In the case of the washing processes of spray residue removal the concensus of opinion is that oil sprayed fruit is somwehat more difficult to wash than fruit sprayed with lead alone or with lead and spreader. Even here the difficulty is by no means insurmountable and is, in general, no greater than in the case of fruit, upon which the natural wax has begun to form. The factors, already referred to, as having influence upon the wiping process, undoubtedly affect the washing process as well. There is good reason for the belief that with increased experience in the use of washing solutions and machinery, oil sprays will offer no material difficulty in the cleaning of fruit.

OIL SPRAY OF MATERIAL AID IN CODLING MOTH CONTROL

The fact has already been pointed out that the majority of growers in the Northwest are by no means satisfied with the control of Codling Moth that they have been able to secure with arsenate of lead. Tests, as well as numerous cases of practical orchard experience, have clearly demonstrated that the combination of oil spray with arsenate of lead greatly increases the effectiveness of the spray application in the control of this pest. It will be readily understood that best results are dependent upon the use of oil spray of high grade, that is, an oil spray that has been prepared with due consideration of the technical and practical features of refinement and volatility, oil content for the specific purpose intended, and emulsification—and last, but by no means least, applied with the greatest possible thoroughness.

Tests this year, conducted under practical orchard conditions, showed approximately three to four times the number of culls for worms and "stings," where the arsenate of lead was used alone, without oil, as in cases where the lead-oil combination was used. One instance of practical results with the lead-oil combination was given by a warehouse manager of one of the large fruit organizations at Medford, Oregon. One of his growers, whose crop consisted mainly of Newtowns and Spitzenbergs, two very susceptible varieties, used the lead-oil combination (a volatile type oil) four times. His total cullage was five per cent. This grower has several neighbors whose fruit was handled by this same warehouse. These growers followed a similar spray schedule, using a similar dosage of arsenate of lead, but without oil. The average cullage for the neighbors' crops was twenty-five per cent. The manager, who is thoroughly familiar with the conditions in these several orchards, stated that in his opinion the only answer to the greatly reduced cullage in this one case was the fact that this grower had used oil spray. Similar results have been secured by many growers of unquestionable experience and reputation in the Northwest.

The lead-oil combination also makes possible a reduction of one to several applications, in the total number of sprays needed to secure good control. While the cost per tank for the lead-oil combination is greater, the reduction in labor cost, for fewer applications, together with a better pack-out for the crop, easily justifies the initial extra expense. The use of the summer oil in the lead-oil combination has the added advantages of reducing aphis infestations, it destroys young or migratory scale and controls Red Spider.

The aim in Codling Moth control should be to secure the best possible results with as few applications and at the least possible expense, consistent with the production of clean fruit. Concentration of every effort against the first brood, with the aim of eliminating this brood, will be found of greatest assistance.

Cases arise where it is desirable to reduce to a minimum the arsenical dosage necessary to secure satisfactory control of Codling Moth, so that little spray residue will be present on the fruit at picking time. Tests indicate that where the lead-oil combination is used, the total arsenical dosage needed for good results can be reduced materially. We are by no means in a position to recommend total dependence on oil spray for Codling Moth control on apples, although several cases can be cited where growers secured good results with oil spray alone. One grower in a badly infested district at Wapato, Wash., secured excellent results on his Yellow Transparent apples, an early variety, with three applications of summer oil, without lead. This grower's total cullage for worms and "stings" did not exceed 2 per cent, and this variety is amply susceptible to worm attack. The long growing season, however, in the case of apples, and the need for frequent or heavy application (certainly in the case of our heavily infested districts and more susceptible varieties), where total dependence is placed upon summer oil alone, introduce factors that require further investigation.

In the case of pears, tests and actual experience have demonstrated that good control of Codling Moth can be secured by the use of summer oil with a greatly reduced dosage of arsenate of lead, and even with the summer oil alone, without any lead. In orchard tests with Bartlett pears the past season, a total of three applications of one of the heavier summer oils, at 1½ gallons in 100, applied at periods approximately one month apart, resulted in a cullage for worms and "stings" of only 1.9 per cent. Where 3 pounds of arsenate of lead in 100 was added to the oil in the first application, the cullage amounted to 1.7 per cent, only two-one-hundredths of one per cent better than with the oil alone. An unsprayed Bartlett for this same locality would cull, conservatively, close to 25 per cent. No ill effects of any sort were noticed from these oil applications on pears. The fruit was of as nice size and quality as any in the district. The fact that pears are, on the whole, less susceptible to worm attack than apples, together with a shorter growing season, undoubtedly accounts for these results with oil spray.

In conclusion it can be said that oil sprays have decided possibilities for material aid in Codling Moth control. The extent of this aid is dependent not only upon oil sprays of high quality at reasonable cost, but upon considerate and intelligent use as well.

MEMBER: I would like to ask if I understood correctly that you have no trouble in removing spray residue?

MR. W. S. REGAN: Yes, we do have a great deal of difficulty removing the residue. The number of applications needed under our conditions to secure good control, makes the problem of residue removal to tolerance an extremely difficult one. I believe, however, that with further experience in the use of washing machinery and washing solutions, the problem will be satisfactorily overcome. That seems to be the attitude throughout the Northwest. At first there was a great deal of opposition to this residue requirement, but most of the people of the Northwest appear to feel that it will eventually be a good thing for the fruit industry.

MR. J. S. HOUSER: By way of supplement to Dr. Regan's paper, I would like to add this point that the combination of oils and arsenicals cannot be used satisfactorily for spraying grapes, because the oil takes the bloom from the fruit.

MR. W. S. REGAN: I might add that the extent to which the bloom is removed and the length of time it remains off is dependent mainly upon the type of oil used. I have had no experience with grapes, but on prunes, which have a similar bloom, by using a lighter, more volatile oil, the bloom may be removed temporarily, but returns in a relatively short time, whereas with a heavy, less volatile oil, the bloom remains off longer.

MR. J. S. HOUSER: I have in mind the white oil emulsions.

MR. W. S. REGAN: I might say that the white oils vary in viscosity all the way from 50 seconds to about 107 seconds, and this would mean that oils of lower viscosity would disappear rapidly after application, whereas the heavy oil is slowly volatile.

MR. ALBERT HARTZELL: How many inches of rainfall did you have in Washington when these exepriments were conducted?

MR. W. S. REGAN: I wonder if Mr. Newcomer could give us that.

MR. E. J. NEWCOMER: I think it is about 9 inches a year. That also includes snow.

MR. W. S. REGAN: Professor Crosby has asked me to mention the fact that throughout our spraying season we may have little or no rain. Last year from May through September we had practically no rain.

FIRST VICE-PRESIDENT W. P. FLINT: The next paper is by S. W. Frost.

CONTINUED STUDIES OF BAITS FOR ORIENTAL FRUIT MOTH

By S. W. Frost, *The Pennsylvania State College*[1]

Abstract

Comparisons of fermenting sugar baits and sodium arsenite-molasses baits were made, with further studies to determine reasons why the sodium arsenite-molasses baits give more satisfactory catches. A summary is given of some factors affecting the catches of Oriental Fruit Moths (*Laspeyresia molesta*). The results of control experiments for 1927 are summarized.

Method. All bait tests and control plots were conducted in a block of Krummel peach trees near Arendtsville, Pa. Number ten tin pails of approximately one gallon capacity, painted with white lead and turpentine, were placed on every tree in all plots. From ten to twenty-four pails were used in each test. These were examined, except in a few cases noted, once a week and the insects were strained from them and counts were made of the number of Oriental Fruit Moths. Records were also kept of a large number of other insects which will be discussed in further papers.

Seasonal Conditions. The summer of 1927 was abnormally cool and rainy. The catches of Oriental Fruit Moths, and likewise all other insects, were correspondingly low especially during the early part of the summer.

The set of fruit in the Krummel block of peaches was exceedingly small due to late frost and freezing in the spring. The adjacent blocks of early peaches were, however, full. During the month of May an unusual number of larvae of the first brood entered the young fruit probably because the twigs in that particular part of the orchard were not growing vigorously at that time.

The percentage of Oriental Fruit Moth infestation was moderate to heavy, approximating that of 1926. The infestations of Elberta, Hale and Hiley were estimated at 5 per cent. On July 29th a count of 250 Mixon, showed 11 per cent infested fruit.[2] An examination of 250 Fox Seedlings on September 3rd showed 31.3 per cent wormy fruit while at picking time, September 26th, Krummels, where the fruit was very thin, showed 83.3 per cent wormy fruit.

The percentage of parasitism was apparently low. No parasites emerged from 500 overwintering larvae which were taken from wormy quinces the preceding fall from the southern extremity of Pennsylvania, at Midvale. During the first summer brood, 200 larvae were gathered but no parasites emerged. About 1 per cent of 500 larvae of the second summer brood were parasitized by *Glypta* while no parasites were reared from 200 larvae of the third summer brood.

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[1] Published by permission of the Director of Agriculture, The Pennsylvania State College of Agriculture as a part of project No. 697. Technical paper No. 445.

[2] The percentages of worms in Mixon and Fox Seedling were determined by rearing adults or dissecting larvae from fruits collected on these dates.

FERMENTING SUGAR BAITS. The investigations of fermenting sugar baits were centered about the catches from various dilutions of (1) a medium grade refiner's syrup (2) "Centrifugal," a low grade New Orleans molasses and (3) "Refodewah," a high grade New Orleans molasses. Analysis of these sugar bearing products with others for comparison were made by Mr. Huber through the courtesy of Dr. James W. Kellogg of the Bureau of Chemistry, Harrisburg, Pa.

ANALYSIS OF SYRUPS

(Through courtesy of Dr. J. W. Kellogg, Bureau Chemistry, Harrisburg, Pa.)

Name	Sucrose	Reducing Dextrose Sugars	Wholesale Cost per Gal.
Refodewah, New Orleans	39.8%	18.5%	80c
Refiner's Syrup No. 694	38.6%	24.2%	45c
Choice Centrifugal New Orleans	37.9%	19.4%	26c
Black Strap, Brand "CC"	32.8%	19.6%	19c
Molasses residue*	less than 1%	Trace	11c

*Several tests of these so called "foundry molasses" or "Evaporated molasses residue" were tried at various dilutions hoping that these highly odoriferous mixtures might be attractive but the results were negative.

The figures, in the chart of weekly collections of moths, plainly show that Refiner's syrup 1-20 is superior to a dilution of 1-10 and that a 1-10 New Orleans molasses "Refodewah" is superior to a 1-20 dilution. The rate of fermentation and surface tension no doubt have a direct bearing upon dilution and ultimately affect the catch.

SODIUM ARSENITE-MOLASSES BAITS. The investigation of 1927 again showed that the sodium arsenite-molasses bait consisting of: New Orleans molasses 1 part, water 10 parts and sodium arsenite 5 grams to 1 gallon of the mixture, gave much higher catches. Compare the results shown in the accompanying chart. Favorable results were obtained when sodium arsenite was used with New Orleans molasses "Refodewah" but not when used with Refiner's syrup or with black strap molasses. While

Weekly Collections of Oriental Fruit Moths by various Baits 1927.

Plot	Apr	May					June				July				August				September				October			Number Pails	Material[1]	Proportion[2]	Additions[3]	Duration	Total Number Moths	Number Moths Per Pail
	26	3	10	17	24	31	7	14	21	28	5	12	19	26	2	9	23	30	6	13	20	27	4	11	18							
A1	1	1	43	16	47	4	3	4	0	3	31															24	Refodewah	1-10	5gr. S.B.	11 wks	153	6.3
B1	20	1	666	93	182	12	12	4	2	9	111															24	Refodewah	1-10		11 wks	1114	46.4
C1	1	0	181	46	248	26	7	7	0	13	78															24	Refiners S	1-10		11 wks	608	25.3
D1	1	0	45	4	71	14	5	1	0	0	1															24	Refiner's S	1-10	3gr S.B	11 wks	148	5.9
E							5	6	2	8	82	63	23	3	43	131	168	19	22	31	93	121	130	97	18	24	Refodewah	1-10		19 wks	1065	44.3
F							0	0	0	19	298	248	112	15	134	381	738	108	89	88	229	303	1296	747	158	24	Refodewah	1-10	5gr S.A	19 wks	4961	206.7
G							2	10	2	10	146	120	28	0	31	32	55	5	2	3	5	10	19	6	4	24	Refiner's S	1-10		19 wks	490	20.4
H							0	0	0	0	26	5	12	3	24	49	111	12	7	10	54	84	433	89	25	24	Refiners S	1-10	5gr S.A	19 wks	942	39.2
A2												219	156	24	104	105	222	19	24	12	47	32	199	42	3	24	Refodewah	1-10		14 wks	1208	50.3
B2												180	37	15	58	45	87	7	5	22	14	12	20	21	0	24	Refodewah	1-20		14 wks	521	21.7
C2												64	52	5	22	37	35	4	6	1	10	2	28	14	0	24	Refiner's S	1-10		14 wks	280	11.6
D2												8	52	17	130	146	187	11	6	14	27	36	158	60	9	24	Refiner's S	1-20		14 wks	861	35.8
I															41	209	132	299	54	8	2	16	26			15	Refiner's S	1-10		9 wks	787	52.4
J															65	147	88	231	79	11	17	12	10			15	Refiners S	1-10		9 wks	660	44.0
K																	229	36	37	16	16	11	53	36	2	10	Refodewah	1-10		9 wks	436	43.6
L																	141	81	95	135	264	144	485	265	12	10	Refodewah	1-10	½gr S.A	9 wks	1622	162.2
M																	234	53	53	87	207	133	554	413	23	10	Refodewah	1-10	1gr S.A	9 wks	1757	175.7
N																		33	13	25	30	34	41	7		1	Refodewah	1-10		7 wks	183	183
O																		22	15	23	43	40	49	25		2	Refodewah	1-10		7 wks	217	108.5
P																		68	36	38	58	61	83	41		4	Refodewah	1-10		7 wks	385	96.2
Q																		87	37	91	131	129	145	86		6	Refodewah	1-10		7 wks	686	114.3
R																		102	52	98	142	129	130	93		8	Refodewah	1-10		7 wks	746	93.2
B3																			46	149	318	203	723			10	Centrifugal	1-20		5 wks	1439	143.9
E3																			Set				1323			10	Centrifugal	1-20		5 wks	1523	132.3

[1] Grade of syrup used in baits.
[2] 1 part of syrup to the designated parts of water.
[3] S. B. =Sodium benzoate, S. A. =Sodium arsenate.

sodium benzoate was suggested in 1926 further studies have shown that it has little value.

Tests were conducted to determine (1) whether unfermented sugars and (2) whether certain sodium salts are attractive to the Oriental Fruit Moths. Numerous tests were run from May until July with various sugars including; lactose, levulose, maltose, arabinose, glucose, dextrose and invert sugar. Unfermented sugars could be tested only in dry form or as highly concentrated mixtures. The sugars were placed in "Peterson's evaporation cups" and floated on top of water, also upon a soap solution or a sodium oleate solution. The latter were used to give better retention of moths on account of lowered surface tension. The sugars were also mixed with a few drops of water and placed in similar "evaporation cups" but neither series of experiments yielded higher catches than water or sodium oleate checks. Dilute mixtures of Invert sugar were also used without favorable results.

Sodium salts were tried including: S. arsenite, S. benzoate, S. borate, S. oleate, S. chloride, and S. hypochlorite. These were tried in powdered form in "Evaporation Cups" floated upon water, also as weak solutions using 1 teaspoon of the salt to 1 gallon of water. A few moths were captured in some of the pails but the results clearly indicated that these salts had no attraction for the moths.

The foregoing experiments indicate that neither the unfermented sugars or the salt in the Sodium arsenite-molasses bait accounts for the superiority of this bait. The attractiveness must be due to some reaction between the molasses and the salt or possibly to a slight inhibitation of the fermentation of the sugars.

SOME FACTORS AFFECTING THE CATCHES OF ORIENTAL FRUIT MOTHS

These factors are too numerous and complicated to summarize here. As a matter of fact we are familiar with only a few of them. Some of the factors as temperature and precipitation are beyond our control but the bait and the pail may at times be adjusted to accommodate themselves to these. Other factors as the surface tension, density and volume of the liquid can be modified at will.

Prolonged low temperatures and excessive precipitation both affect the catches of Oriental Fruit Moths. The small catches of the past cool, wet season are outstanding. It is still questionable whether the reduced catches under such conditions are due to (1) the inactivity or checked fermentation of the bait, (2) the reduction in the population of the moths in the orchard, or (3) the inactivity of the adults with the result that they do not reach the pails. The latter has been generally believed to be the case. This is certainly true when showers occur at dusk or sunset at which time the moths are normally more active, but on the whole, showers or drops in the temperature for short periods, affect the catches but little.

The presence of large insects in the bait-pails, as: Euphoria and Noctuidae, in moderate numbers are beneficial for they keep the surface of the bait churned and prevent the formation of a scum (mold growth and bacterial growth). On the other hand an abundance of such insects might interfere by filling the pail. Such a condition has never been experienced by the writer because he uses deep pails permitting ample room for the insects to settle to the bottom. During 1927 a set of 100 pails was tested from August 1st to September 1st without any attention, and at the end of this period the surface of the baits were clean, the moths had settled to the bottoms of the pails, and 20,000 Oriental Fruit Moths were separated and counted from these pails. In this connection it might be mentioned that the peak of emergence of the Noctuids, which includes numerous species, comes about the first of June. This may vary with different seasons. A curve was plotted for 1927 based on 23,574 Noctuids caught in 300 pails. In constructing the curve the catch per pail was used. The great Noctuid flight precedes the first, second and third summer broods of the Oriental Fruit Moth and therefore is not a serious factor in the operation of baits. It is interesting to note also that 25,486 Oriental Fruit Moths were taken from the same 300 pails.

Another factor of considerable importance is surface tension. This was first discussed by the writer in 1925 when he noted that larger numbers of moths were caught in molasses baits when a small amount of engine oil was placed on top to prevent evaporation and slopping, than in similar molasses baits without the engine oil. This brings us to the problem of attraction vs. retention. Both are factors contributing to the catches of moths in liquid baits. Water does not offer a suitable check in orchard work. There is little or nothing to hold the moths that visit it. On the other hand a molasses solution not only attracts but through its reduced surface tension causes the moths to penetrate the surface and prevents them from getting away. This is clearly illustrated by the following tests: Oriental Fruit Moths were introduced on many different occasions into three similar battery jars, each containing a jelly glass. Water, a molasses solution, and a Sodium oleate solution

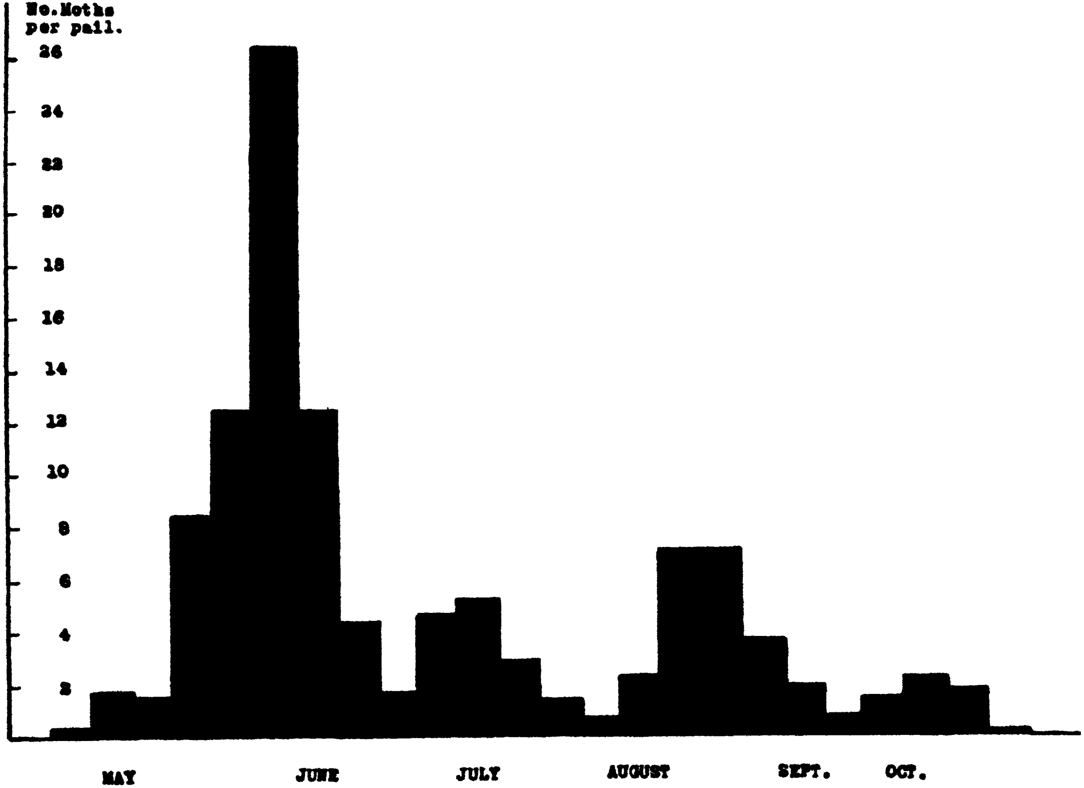

Fig. 22—Noctuids caught in bait pails (Based on 23,574 Noctuids caught in 1000 pails)

was placed in the three respective jelly glasses. The top of each battery jar was covered with cheese cloth and all jars were placed in an out-door insectary. Two hundred and sixty-two moths were introduced into each jar on various days from May 9th until September 30th. Daily counts were made of the number of moths caught in the different liquids. The total catches were as follows: 74 Oriental Moths in plain water, 155 moths in the molasses solution, and 202 moths in the sodium oleate solution. It was difficult to keep the surface of the water clean. The floating scales of the moths made it easier for the adults to penetrate the surface film. On the other hand, a scum formed on the surface of the molasses solution, under these artificial conditions, making it more difficult for the moths to penetrate the surafce film. The comparison, therefore, is not as favorable as it should be.

Field tests were also conducted to determine the value of surface tension using double containers. The inner container was the same size as the regular bait pail. Outside of this was a second chamber with a diameter three inches greater than the inner container. Bait was placed in the inner containers of two such pails. Water was put in the outer chamber of one of the pails and a sodium oleate solution in the outer chamber of the other. The bait served in both cases to attract the moths while the number of moths caught in the outer chambers indicated the difference in retention power of the two liquids under test. The difference was very noticeable but it was impossible to make counts at the end of each week because the moths disintegrated in the sodium oleate solution.

Over three hundred measurements were made at the laboratory of the surface tension of various sugar solutions at different dilutions and stages of fermentation. It was soon found that the surface tension of a molasses solution was considerably lower than that of water but much higher than that of a sodium oleate solution. The production of alcohol and later, the production of acids in the fermenting sugar solution both tend to reduce the surface tension. The relative values of the surface tension of water, molasses solution and sodium oleate solution are shown in the following table.

RELATIVE VALUES OF SURFACE TENSIONS AT 20°C.

Material	Surface Tension in Dynes per Cm.
H_2O	70
Molasses 1–20	58.3
Sodium oleate .025 gr. to 100 cc H_2O	31.6

The surface tension of a solution of black strap molasses is higher than that of a similar dilution of refiner's syrup or New Orleans molasses, which helps to account for the fact that a New Orleans molasses solution gives better catches of oriental fruit moths than a similar solution of black strap molasses. It was noticeable in the orchards that larger numbers of the heavier Codling moths were caught in black strap molasses than the smaller Oriental Fruit moths.

Other factors as: the height the pails are hung, size of the opening, color of the pail and the amount of material in the pail have been discussed before. The question of the number of pails per acre or given area to give the largest catch, has not been completely determined. In 1925 "a pail on every other tree in every other row" was suggested. During 1927 a pail was hung on every tree. The indications are that these are both extremes and that a pail on every other tree or about 50 pails per acre will give a maximum catch. There are reasons to believe that the catch per pail when the pails are hung on every other tree approximates the catch per pail when the pails are hung on every tree. Tests were conducted hanging 1, 2, 4, 6 and 8 pails respectively on 5 different widely separated trees in the same block. The chart of weekly collections show the results; approximately the same catch per pail whether 1 or 8 pails were hung on the same tree.

From the experimental standpoint it was thought that the daily or weekly disturbance of baits in making collections of moths might favor the bait by tending to keep it clean and free from insects. The following tests of weekly vs. monthly collections do not bear this out and it is also apparent that other insects, at least in moderate numbers, have little or no detrimental effect upon the bait.

WEEKLY COLLECTIONS VS. MONTHLY COLLECTIONS OF ORIENTAL FRUIT MOTHS FROM BAIT-PAILS

Bait	Centrifugal 1–20	Centrifugal 1–20	Centrifugal 1–20	Refodewah 1–10	Refodewah 1–10
Number[1] of Pails	24	24	10	10	10
Duration	Sept. 1–Oct. 1	Sept. 1–Oct. 1	Sept. 1–Oct. 1	Aug. 1–Sept. 1	Sept. 1–Oct. 1
Examined	at end of 30 days	Every 7 days	at end of 30 days	at end of 30 days	at end of 30 days
Total number moths	1323	1439[2]	1097	1907	356[3]

[1] 100 pails were used in each test but only the indicated number were selected for counts.

[2] The total number of moths for 4 collections during the month.

[3] A continuation of the same bait used in the preceding column.

Control Experiments. No effort was made to keep the control plots properly pailed for it was early recognized that the crop of Krummel peaches would be exceedingly shy. Only eleven bushels, the total crop, was picked from 200 trees in the four plots from which counts were made namely, Plots (A & B), (C & D), (E & F) and the check or unpailed plot. The letters refer to the series of pails, one on each tree, given in the chart of weekly collections of Oriental Fruit Moths and gives more plainly than words the treatment these plots received.

SUMMARY OF ORIENTAL FRUIT MOTH INJURY

Drop Fruit 50 Trees in Each Plot

Plot	Total Number of Fruit	Number of Sound Fruit	Number of Wormy Fruit	Percentage of Wormy Fruit
A–B	174	24	150	86.2
C–D	455	53	402	88.3
E–F	507	56	451	88.9
Unpailed	357	20	337	94.3

Picked Fruit 50 Trees in Each Plot

Plot	Total Number of Fruit	Number of Sound Fruit	Number of Wormy Fruit	Percentage of Wormy Fruit
A–B	282	53	229	81.1
C–D	638	180	458	71.7
E–F	834	279	555	66.5
Unpailed	504	84	420	83.3

The higher percentage of picked wormy fruit in plot A–B may be due to its location at the edge of the orchard and to the greater scarcity of fruit. It is worth noting that 10,913 oriental fruit moths were removed from plots A–B, C–D, and E–F, from April 26th until October 18th. Only 24 per cent of these were taken before July 1st and 36 per cent before August 1st. Seventy-two moths were taken per tree or approximately 4 moths per fruit.

Bait and Container. In general a bait of refiner's syrup 1 part and water 20 parts, has given the largest catches of moths. Under extreme conditions such a bait is good for a month and under favorable conditions for at least two months. (During August 20,000 oriental fruit moths were taken from a set of 100 pails which were not disturbed for a period of thirty days. The pails were hung on every tree thus covering about an acre.) A sodium-arsenite molasses bait, under extreme conditions is good for four or five months. The latter bait may prove more satisfactory during hot summers when fermentation proceeds too rapidly.

Further studies are necessary to determine the minimum amount of sodium arsenite that can be used.

The ideal container is a No. 10 tin pail of approximately one gallon capacity with an opening of 6 inches and a depth of 7 inches. It holds enough material to overcome undue evaporation and gives depth to accommodate Noctuidae and other insects that sink to the bottom, thus clarifying the surface. A bail or handle of No. 15 galvanized wire cut two feet long makes a good handle. The wire is brought together and bent over at the top to form a hook. During the past two summers the pails were painted inside and out with white lead and turpentine. Enamels and oil paints proved unsatisfactory because they blistered and peeled off. Preliminary tests have been made with asphaltum paint and during the coming season a mixture of asphalt and spirits will be used for the interior of the pails while white lead and turpentine will be used for the exterior. The cost of such pails, including labor, paint and pails, is less than $1.30 per 100 when pails can be secured free. Discarded or slightly blemished containers can be purchased f.o.b. factory for less than $4.00 per hundred. Methods for dipping the cans could easily be worked out if bait-pails prove satisfactory.

CONCLUSIONS. There are some favorable figures to lead one to believe that bait pails have a place as a means of control for the Oriental Fruit Moth. On the other hand there are some unfavorable and uncertain seasonal conditions that greatly reduce the catch of moths with the baits in use at present. On the whole, however, the inexpensiveness of bait pails, the comparative small amount of labor required to attend to them, and the figures thus far accumulated in their favor, leads the writer to believe that bait pails may find a definite place in the control of the Oriental Fruit Moth.

ADJOURNMENT: 12 o'clock.

Friday Afternoon Session, December 30

The meeting convened at 1:35 o'clock, President R. W. Harned in the Chair.

PRESIDENT R. W. HARNED: The first paper this afternoon is by J. M. Robinson.

A NEW INSECT PEST OF PECANS IN ALABAMA, TETRALOPHA SP.

By J. M. ROBINSON, *Auburn, Ala.*

(Withdrawn for publication elsewhere.)

PRESIDENT R. W. HARNED: The next paper is by H. L. Sweetman.

PRECIPITATION AND IRRIGATION AS FACTORS IN THE ECOLOGY OF THE MEXICAN BEAN BEETLE, *EPILACHUA CORRUPTA* MULS.

By HARVEY L. SWEETMAN, *Wyoming Agricultural Experiment Station*

(Withdrawn for publication elsewhere.)

PRESIDENT R. W. HARNED: The next paper is by R. N. Chapman.

QUANTITATIVE RESULTS IN THE PREDICTION OF INSECT ABUNDANCE ON THE BASIS OF BIOTIC POTENTIAL AND ENVIRONMENTAL RESISTANCE[1]

By ROYAL N. CHAPMAN, *Division of Entomology, University of Minnesota*

ABSTRACT

One may not assume that a change in insect population has been caused by a change in some environmental factor unless it is known that when the environment is constant the population is constant. Results from constant population experiments are compared with observations on the European Corn Borer.

It may be permissible to call attention to certain results from quantitative experiments and to stress the economic significance of such work in this age of qualitative biological description. It is impossible to distinguish between the results of chance and the operation of laws which involve cause and effect in the phenomena of nature, without the establishment of certain constant values with respect to the phenomena under consideration. The day of recognition for the calculating, quantitative, economic entomologist has not yet come, but the day of descriptive observation of the obvious and guessing as to the probable is nearly past.

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[1] Published with the approval of the Director as Paper No. 769 of the Journal Series of the Minnesota Agricultural Experiment Station.

Whether we welcome it or not we shall be forced to repeat the history of the more exact sciences in the solution of our problems which are becoming increasingly more difficult as we approach the limits of our present methods.

A series of experiments has been carried out for the purpose of demonstrating whether or not a constant value could be arrived at for the number of insects in an environment of unit size. The question of the constancy of the abundance of insects under known experimental conditions may be an academic one, nevertheless, it is impossible to proceed with any sort of prediction with regard to future populations of insects unless it is known that the abundance of insects will always be the same, if their environment always remains the same.

The insects used in these experiments were confused flour beetles (*Tribolium confusum*) and the environments were especially constructed glass dishes containing pure whole wheat flour maintained at known temperature and humidity. All of these conditions are admittedly simple and the contention is that they are therefore more dependable and practical. The set of eighteen environments involved various combinations of geometric series of sizes of environments and geometric series of sizes of original populations. In spite of these differences in the original size of populations and the absolute size of the environments, the populations as expressed in individuals per gram of flour, had a value of 43.97 with a standard deviation of 4.27 and a probable error of 2.88. This constant is good as compared with other so-called biological constants and may even claim respectability along with certain physical constants. This is especially true when it is recalled that physical laws deal with large numbers while biologists have a tendency to try to deduct laws from the behavior of individuals.

It is important to note that certain of these experiments were started with single pairs of beetles so that all the individual differences in rates of egg laying, length of life, etc., appeared as factors in the beginning of the experiments. As time went on these differences disappeared as a result of nature's own method of averaging as the populations approached the point of saturation. The result is that in 154 days' time the progeny from single females varied from 178 to 4482. The size of the population being proportional to the size of the environment.

Here then is a case in which the abundance of insects can be predicted when the measurements of the environment are known. The calculations can be carried out by the use of a simple formula based upon the assumption that the number of insects is equal to the potential rate of production divided by the resistance of the environment. $(C=\frac{Bp}{R})$.

Taking the constant value for the number of insects "C" and the average number of eggs laid by each female each day, multiplied by the number of females at the start of the experiment, we can solve for the value of the environmental resistance "R". $R=\frac{Bp}{C}$, $R=\frac{(43.97 \times 8.4).25}{43.97}=2.1$.

When the value of R is known it is then possible to calculate the number of insects $(C=\frac{(43.97 \times 8.4).25}{2.1}=43.97)$.

The fact that the above case is a simple one and that the measurement of the environment amounts only to determining the number of grams of flour, does not detract from the applicability or promise of the method. The fundamental principles of the method can be applied to any problem in which it is possible to make some determination of the number of insects involved, and their rate of reproduction.

We are told, for instance, that the concentration of the corn borer (*Pyrausta nubilalis*) in cornfields of a certain area was 2 larvae per 100 stalks in 1925, 8 larvae per 100 stalks in 1926 and 13 per 100 stalks in 1927. Accepting certain published averages with regard to the rate of reproduction we may assign a value of 185 to the biotic potential. The environmental resistance for the period 1925 to 1926 will then be 46.25 whereas it is 113.84 for the period of 1926 to 1927. It may be the assumption that the increase of 67.59 in the resistance was due to certain control measures. However this may be, the fact remains that a theoretical value of 185 for the environment resistance is necessary to prevent further increase and that greater values are necessary to reduce the numbers. Upon examination of further data from the same source, it is found that in western New York environmental resistance had a value of 487.7 between 1921 and '22, 311.13 between 1922 and '23, and only 48 between 1923 and '24. The change in environmental resistance in the critical period of 1926 to 1927 seems insignificant as compared to the changes which took place in other years in western New York. Consequently we find that we are not justified in drawing any conclusions with regard to the cause of the reduction in the infestation in 1927 or what portion of the reduction of infestation was due to control measures.

In this case the chief contribution has been in translating what is known regarding the ratios of the potential and actual rates of increase into a common denominator as environmental resistance. The result indicates the necessity for further critical work in order that we may measure the effect of various environmental factors and control measures. Until we adopt such critical measurements we shall never know whether we are making progress or not.

PRESIDENT R. W. HARNED: The next paper is by W. V. Balduf.

THE BIONOMICS OF *POLYNEMA STRIATICORNE* GIRAULT (MYMARIDAE, HYMENOPTERA) A PARASITE IN THE EGG OF THE BUFFALO TREE HOPPER, *CERESA BUBALUS* FABR. (MEMBRACIDAE, HOMOPTERA)

By W. V. BALDUF, *University of Illinois, Urbana, Ill.*

(Withdrawn for publication elsewhere.)

First Vice-President W. P. Flint assumed the Chair.

MR. L. O. HOWARD: Are there hosts known for this species?

MR. W. V. BALDUF: Hodgkiss reported four other species.

FIRST VICE-PRESIDENT W. P. FLINT: The next paper is by C. A. Weigel.

RESULTS OF FORCING HOT WATER TREATED NARCISSUS BULBS

By C. A. WEIGEL, *Entomologist,*[1] *Washington, D. C.*

ABSTRACT

The treatment of dormant narcissus bulbs in hot water for a period of 3 hours at a temperature ranging from 110° to 111.5° F. is today recognized as a means of controlling infestation by the nematode, *Tylenchus dipsaci* Kuhn, the bulb flies, *Merodon equestris* and *Eumerus* spp., and the bulb mite, *Rhizoglyphus hyacinthi* Boisd. The results of the first year's experience, however, with this treatment of both home grown and newly imported narcissus bulbs were variable, success being attained in some sections while in others disastrous effects were noted. The causes of these failures, however, have not been clearly established. In some cases they were thought to be due to planting the bulbs while still hot and wet, i. e., without properly drying them before planting. In others they were attributed to very early planting, at a time when the soil temperatures were high and accompanied by either

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[1] Tropical and Sub-tropical Plant Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture.

excessive moisture or dryness. Under such conditions it was thought that the bulbs were weakened and rendered more susceptible to attack by diseases such as basal and other rots which ultimately hastened their destruction. Some growers thought failure was due to possible overheating of bulbs, which may have occurred while the bulbs were in transit, or to improper storage before and after treatment.

These facts forced attention to the need of carefully studying the many details involved in the hot water method as a basis for definite recommendations as to time and manner of treatment for the different localities where bulbs are grown.

Experiments conducted during the past year, using paperwhite narcissi which were treated at 110° to 111.5°F., indicated that there was a general tendency toward better flower production in bulbs treated about August 11, as compared to those treated on September 1 and October 1. It was also determined that paperwhites will not tolerate the higher temperature of 115°F. At this temperature the number of individual flowers produced per spike was greatly reduced.

In case of the trumpet narcissi, including Golden Spur, Emperor, King Alfred, Victoria, and Spring Glory, a very satisfactory crop of flowers was produced in both the treated and untreated lots.

In general these tests indicate that the varieties of bulbs mentioned above can be given the hot-water treatment without materially reducing the degree and quality of flowering. It is also evident that when stock is treated at the right stage of growth, and handled properly before and after treatment, it may safely be shipped from one section of the country to another without great risk of loss from the treatment.

A detailed account together with illustrations of these experiments, written from the viewpoint of the grower, was published in the August 4 and September 15, 1927, issues of the *Florists' Review.*

FIRST VICE-PRESIDENT W. P. FLINT: The next paper is by Miss B. M. Broadbent.

DEVELOPMENTAL HISTORY OF THE NARCISSUS BULB FLY AT WASHINGTON, D. C.

By BESSIE M. BROADBENT, *Junior Entomologist, Tropical and Subtropical Plant Insect Investigations, U. S. Bureau of Entomology, New Orleans, La.*

• ABSTRACT

The 1927 observations on the development of the Narcissus bulb fly, *Merodon equestris* Fab., varied slightly from 1926. These differences are largely due to temperature as indicated by analysis of the records in relation to environmental conditions. It is shown by partial correlation that temperature and time of day are important factors influencing the activities of the flies. New data on exact duration of larval period and total life cycle are presented. No evidence of two year larval period found.

An account of the detailed life history of the Narcissus bulb fly, (*Merodon equestris* Fab.), at Washington, D. C. was published in an earlier paper.[1] At that time no exact records on the duration of the larval period and the total life cycle were available. This deficiency has been remedied by rearing experiments completed during the spring of 1927. A comparison of these new data with the previous records for 1926 disclosed differences in the duration of several of the developmental stages. Accordingly not only the recent data but the earlier records as well have been correlated with environmental conditions in an attempt to account for these differences.

TEMPERATURE RECORDS. Of the environmental conditions temperature proved the most important factor. In this species the larvae feeding in the bulbs, and the pupae just beneath the surface of the ground develop presumably at the temperature of the soil with which they are in contact. The eggs and the flies on the contrary occur above ground and are exposed directly to the prevailing air temperature.

Soil temperatures in the outdoor screened insectary where the flies were reared were recorded three times daily, at 8:30 a.m., 12:00 m., and 4:30 p.m. These readings have been compared with the Weather Bureau air temperature records for the same locality for the corresponding hours. There was a high correlation between the two series of records, with correlation coefficients as follows:

At 8:30 a.m. $r = .977 \pm .002$
12:00 m. $r = .939 \pm .029$
4:30 p.m. $r = .924 \pm .007$

The soil temperatures were somewhat more stable and appeared to change more slowly than the air temperatures. Thus for high air temperatures the corresponding soil temperature was not so high, and for low air temperatures the soil was usually slightly warmer. The greatest divergence occurred in the afternoon, and the closest agreement in the morning readings.

In the absence of night readings on soil temperature, the mean daily soil temperatures have been assumed to diverge from the mean daily air temperatures as the 8:30 readings. The regression coefficient of soil temperature on air temperature was .926, and rectilinear throughout the range, (25° -89° F.).

EGG STAGE. The average duration of embryonic development for the two years was 12.15 days (354 eggs) covering a range of from 10 to 14 days at temperatures from 17.1° to 20.5° C. The two years were in close agreement except for two aberrant individuals in 1927. These required 17 and 19 days to complete the egg stage.

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[1] Journal of Economic Entomology, Vol. 20, No. 1, pp. 94-113.
The writer is indebted to Dr. C. I. Bliss for assistance in analyzing the data, and in preparing the present report.

LARVAL PERIOD. Larvae which hatched between May 28, and June 6, 1926 were carried through to pupation which was first noted on March 16, 1927. At that time a number of larvae had already pupated. Judging from the eversion of the anterior respiratory spiracles by these individuals six days later, it is estimated that under the prevailing temperature conditions the earliest pupation had probably taken place about March 11. The average length of the larval period based on records for sixteen individuals is 290 days, the maximum time being 303 days. As nine of these larvae averaged perhaps four days less than the observed records, the actual average probably lies between 287 and 290 days.

The early pupation records may be explained in part by higher temperatures during the first three months of 1927, as compared with the corresponding interval in 1926. For example, during 1927 the mean daily temperature for January was 1.0° F. higher than normal; for February, 7.2°; and for March 4.6°. It has been shown by studies on the rate of development in Drosophila[2], and other forms that a given change in temperature has a more marked effect upon the duration of a stage when the prevailing temperature is low than when it is high. Departures from normal in mean daily temperature during the cold part of the year would be more effective therefore than an equivalent change during the heat of summer.

In 1926 pupation occurred from March 25, to April 17, and was associated with an average daily temperature deficiency of 0.6° F. from January through March, which may have prolonged the larval period a few days. Pupation in 1927 was two weeks earlier, from March 11, to April 2, and these larvae had been exposed to an average daily temperature excess of 4.3° from January to March inclusive. During a normal year therefore the larval period would probably average about 300 days.

NO TWO YEAR LARVAE. In studies of this bulb fly continuing over a period of three years from 1925 to 1927, we have found no evidence indicating that some larvae of this species may require two years to complete their development. In no instance have we found living larvae remaining in the bulbs the second summer. At the conclusion of our rearing experiments we have found only empty puparia, and in a few instances dead larvae or pupae that failed to emerge.

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[2] Temperature characteristics for prepupal development in *Drosophila melanogaster*, by Chester I. Bliss, Journal of General Physiology, March 20, 1926, Vol. 9, No. 4, pp. 467-495.

We have found very marked variation in the rate of growth of individuals of the same age even when feeding in the same bulb, and feel that this could easily lead to inaccuracy in estimating their ages. For example, two larvae which hatched at the same time were measured after each had been feeding for sixty days. One larva was more than twice the size of the other. In another instance, two larvae measured exactly 15 x 5 mm., yet one was 161 days old, and the other only 92.

Pupal Period. Pupal development is divided into two unequal periods by the eversion of the anterior respiratory spiracles. The first period ends with the extrusion of these spiracles, and the second continues until the final emergence of the fly. Based upon mean temperatures, corrected for soil readings, development to the first external appearance of the spiracles is primarily dependent upon temperature. During the past two years these spiracles have been extruded in from 9 to 26 days after pupation at temperatures varying from 7.3° to 12.7° C. The remainder of the pupal period varied from 24 to 44 days, and the corresponding range in temperature was 12.2° to 18.5° C. Due to the distinctness of the temperature ranges, the two stages of pupal development could not be satisfactorily compared. In both cases, however, a large temperature characteristic was indicated.

In 1927 mean temperatures associated with the entire period were lower than those of the previous year, varying from 11.8° to 13.2° C., and the duration of the pupal period was correspondingly longer, ranging from 48 to 61 days, as compared with 33 to 50 days, at temperatures of from 12.0° to 15.7° C. in 1926.

Emergence. Differences in emergence noted in 1926 and 1927 show the dependence of emergence on time of day and temperature. On warm days, under favorable weather conditions, most of the flies come out between 7 and 8 in the morning or earlier. On cooler days emergence is delayed and may be scattered over the forenoon, continuing even into the afternoon. On cold wet days it may be deferred altogether.

Conditions for the reaction of emergence are distinct from development as such and may tend to lengthen the pupal period, as in the case of Drosophila already cited.

Copulation. A day or two after emergence the flies are sexually mature and copulate. Copulation was observed to continue from 3 to 11 minutes, and averaged 6 minutes. Variation in the duration of mating was largely a function of the time of day. Copulation took place between 8 a.m. and 3 p.m. The flies remained together longest in the morning, and the duration of copulation reached a minimum about noon after which time it varied only slightly for the rest of the day. Temperatures associated with mating ranged from 18° to 29° C. Above 22° C, temperature had very little effect on the time spent in copula. These two effects of time of day and temperature have been separated by partial correlation methods. The multiple correlation coefficient R=.63 ±.13.

TOTAL LIFE CYCLE. Eggs laid from May 17, to 25, 1926 produced flies that emerged from May 4 to 20, 1927. The entire cycle from egg deposition to adult emergence, based on exact records for fifteen individuals, varied from 346 to 363 days. The average time was 355.06 ±.52 days.

Data on the longevity of cage-reared flies during 1926 and 1927 showed no significant sex differences in survival expectancy. The average length of life, based on a total of 134 flies of both sexes, was 15.6 days. Adding this to the average time of development from egg to adult gives 370.66 ±.52 days for the duration of the total life cycle.

President R. W. Harned resumed the Chair.

PRESIDENT R. W. HARNED: The next is a paper by F. A. Filinger.

OBSERVATIONS ON THE HABITS AND CONTROL OF THE GARDEN CENTIPEDE, *SCUTIGERELLA IMMACULATA* NEWPORT, A PEST IN GREENHOUSES

By GEO. A. FILINGER, *Ohio Agricultural Experiment Station*

ABSTRACT

The garden centipede, *Scutigerella immaculata* Newport, is becoming a serious pest in greenhouses. This paper discusses some of the habits of this pest and deals with some of the control measures which have been tried and found to be of value.

During the last few years the so called garden centipede (a Symphylid), *Scutigerella immaculata* Newport, has proven a pest of considerable economic importance in greenhouses of Illinois, Indiana, New York and Ohio. Woodworth (1905) reported injury to asparagus in California and was perhaps the first to point out the economic importance of this pest, while damage to greenhouse crops was first reported by Davis (1912), who states that fern-asparagus and smilax were injured in Illinois as early as 1908. Within the writer's experience, lettuce, cucumbers, tomatoes, sweet peas, snapdragons and smilax growing under glass have been severely injured, occasionally amounting to a total loss of the crop. Moreover during the summer months outside crops in the vicinity of the houses have been attacked. In general, therefore, it may be said that the garden centipede will live on a wide range of living vegetable tissue and perhaps upon decaying vegetable matter within the soil.

LIFE HISTORY AND HABITS. Eggs are laid during the early part of the summer in the subsoil runways of the creatures, usually in clusters of 4 to 20. They are white, spherical, about ½ millimeter in diameter and decorated with a network of ridges. At room temperatures the eggs hatch in about 14 days. When the larvae first hatch they have ten dorsal scuta, six pairs of legs and six-jointed antennae. First molting takes place in one to four days, usually within 24 to 36 hours. Another pair of legs is added at this molt and the creatures become very much more active. At each successive molt, which occurs 7 to 14 days apart, a pair of legs is added until the creatures have 12 pairs. This, however, cannot be considered a mark of maturity since some individuals have been observed to molt twice after the twelfth pair of legs was acquired.

Rearing of these creatures is done in petri dishes on a thin layer of soil and in Stender glass dishes into which is poured a "muck-plate" made by mixing 10 parts plaster of Paris and 3 parts of finely ground muck. Plaster of Paris rearing plates were first used by E. M. Searls of the Bureau of Entomology for rearing the cucumber beetle and from this was developed the plaster of Paris-muck plate. The latter is preferred because it is much easier to find white eggs on its surface and to observe the whitish creatures as they move about on the plate. Lettuce leaves are placed on the surface of the plates for food and as a hiding place. Rearing records show that the creatures may live 11 or 12 months.

In their search for food, breeding places, etc., the garden centipedes do not seem to be able to make their own burrows through the soil, hence they depend upon other means, such as earthworm burrows, cavities left by decaying roots and on natural soil crevices. The creatures line these passageways with a light webbing. They seem to "feel" their way with their antennae along these webs as they move about.

There are several possible ways of spreading the garden centipedes. As they are found out of doors in the truck fields and in undisturbed soil along streams the pest can easily be brought into greenhouses with any soil moved in. Manure is often stacked outside of greenhouses and becomes infested. The creatures are then taken into the houses with the manure used. The exchange of plants may be a means of spreading the pest.

Injury to crops is done to the underground parts or parts in contact with the soil. The creatures destroy the fine root hairs and small rootlets, thus stunting the plants and often killing them outright. Small depressions are often gouged out about the crown of plants and small holes are drilled into such root-plants as beets, carrots, and radishes. Where plant leaves happen to lie flat on the ground they are riddled with holes.

Injury to greenhouse crops usually starts along the paths or walls where the soil is undisturbed by cultivation, indicating that the undisturbed soil harbors the pest and has unbroken burrows through which the creatures can move out to plant roots. As earthworms and other forms move out from under paths the centipedes follow the burrows into the plant beds.

With the approach of warm weather in the spring, under greenhouse conditions, the creatures move down into the moist subsoil to a depth of about 18 to 36 inches where they lay eggs and spend the summer. The centipedes seem to be able to live a long time on the organic matter in the soil. In the fall, following the moistening of the soil and the starting of crops, the centipedes again migrate to the upper layers of soil and feed during the fall and winter on plant roots.

CONTROL. There are at least two species of true centipedes which have been observed to prey on the garden centipedes. One species, *Lithobius forficatus*, Linn., is a dark-brown creature about an inch long. The other, *Poabius bilabiatus* Wood, is a much smaller, light-brown centipede. The writer had occasion to visit a greenhouse where these two species were numerous and were no doubt responsible to a great extent for the control of the garden centipedes which ruined crops in this house for several years before the predaceous forms became abundant.

Where practical, raised benches should be used; thus breaking the connection with the subsoil where the creatures seem to breed. Plants grown in raised benches are seldom affected by the garden centipedes.

Thoroughly working the soil in the intervals between crops when the pest is still in the surface layers always checks them as many are killed by this process. Then too the burrows and passageways are broken, decreasing the possibilities of the centipedes getting to plant roots.

When the plants are first set out they should be watered lightly. If the beds are soaked heavily, earthworms and other forms will come to the surface, leaving burrows and passageways for the centipedes to follow. Watering can be increased after the plants have become established.

Paradichlorobenzene has proven a good soil fumigant in controlling the garden centipedes. This should be applied during the summer or early fall while the creatures are still in the subsoil. The surface soil is removed and the material scattered on the subsoil at the rate of 1½ pounds to 100 square feet. The surface soil is then replaced. Not only does the paradichlorobenzene serve as a barrier but undoubtedly many of the centipedes are killed by the slowly generated gas. Care should be taken to keep this material from coming in contact with plant roots.

Steam sterilization with the tile system is perhaps the most effective control yet devised. This must be done during the part of the year when the creatures are in the upper layer of the soil, above the tile. A good way is to moisten the soil in the early fall, thus cooling it. A scattering of lettuce seed will help to attract the pest to the surface. When the creatures are seen feeding on the lettuce-seedling roots, sterilize throughly, heating a whole bed at a time if possible. All paths should be spaded up so as to allow heat to penetrate the soil and to break up the harboring places.

In conclusion it may be said that permeating the whole matter of control is general sanitation and also the correlation of the method employed with the seasonal activities of the pest.

ADJOURNMENT: 2:30 o'clock.

Section of Apiculture

Tuesday Afternoon, December 27, 1927

The meeting of the Section of Apiculture, held in connection with the Fortieth Annual Meeting of the American Association of Economic Entomologists, at the Y. M. C. College, Nashville, Tennessee, convened at 3:15 o'clock, Mr. F. E. Millen, presiding.

CHAIRMAN MILLEN: The meeting will now come to order.

The first paper on the program this afternoon is the Chairman's Address. I will ask Mr. Nolan to take the Chair.

Mr. W. J. Nolan took the Chair.

Mr. Millen read his address:

UNDERGRADUATE COURSES FOR APICULTURE SPECIALISTS

By F. E. MILLEN, *Guelph, Canada*

The science of Apiculture has developed from a small beginning twenty years ago, when the teaching of Apiculture in the colleges of North America could be counted on the fingers of one hand. Today the subject is recognized as a distinct branch of biology in a large number of educational institutions.

Students in Apiculture no longer have to face the often thinly veiled hints of pity from friends, when they know one has decided to enter this field as a life's work. This was a common occurrence a few years ago and many a man was thought literally to "have a bee in his bonnet." The early entomologists passed through the same experience. Results have long since proved, however, that the Agriculturist would have found it impossible to have continued in business if it were not for the ceaseless efforts which the entomologists have made and are still making. Untold millions of dollars have been saved to the country, by the untiring work of these men. The aim of the Apiculturist should be to serve the same purpose, to those keeping bees, as the entomologists have in the broader field. To be best fitted it must be "Science with practice."

For the first and second years a general course, including the usual subjects leading to the Bachelor's degree in Agriculture seems advisable. If an elementary course in Apiculture, with some practice, is included, those students interested in specializing in this branch are given the opportunity of continuing, should the desire be aroused. Comparatively few students, on entering college, have decided to specialize along any one line of agriculture and the generalized courses in the Junior years, while broadening the mind often open the way to one particular field. The Apiculturist should also have a wide knowledge of farm practice, because this information is helpful in creating a bond of sympathy between the Scientist and the Agriculturist in all future work.

Once the student has decided that Apiculture is to become his major work, the need for a thorough understanding of the practical side of beekeeping cannot be too strongly emphasized. We require at least two summers to be spent with a commercial beekeeper and one season in apiary inspection work. The student who fails to secure this experience early in his career cannot expect to reach the goal of highest ambition, to serve "Science and Practice," and a knowledge of men are essential if the final results are to prove lasting and satisfactory. As Charles E. Hughes has said, "In all our educational schemes it must be never forgotten that you cannot by the study of books alone, obtain the equivalent of contact with men." Let us be sure then, that at the beginning our students in Apiculture are intensely practical and have a knowledge of men. In this way they are better fitted to grasp the needs of solving the many problems which call for the aid of Science. During the Senior years the student will understand the reason and necessity for a course based on biological subjects, together with minor courses to prepare for graduate study later. It must not be forgotten, too, that there is a business side to Apiculture. The beekeeper is now faced with the situation, similar to other agriculturists, in that there is little spread between the costs of production and the price received for apiary products. For these reasons the student well trained in phases of economics, organization and marketing, may increase his usefulness to the people he hopes to serve.

If these needs are kept in mind the graduating student will be fitted to start work immediately, or he will be in position to continue graduate *work with profit.*

Chairman Nolan: I am sure few teachers in North America, at least, have had as much experience as Professor Millen in teaching beekeeping. As you all know, Professor Millen is the only one teaching beekeeping on this continent who has a separate building to house his own department. Professor Millen's paper is now open for discussion. If there is no discussion Professor Millen will resume the Chair.

Professor Millen resumed the Chair.

Chairman Millen: The next paper will be by Mr. George E. Marvin.

THE OCCURRENCE AND CHARACTERISTICS OF CERTAIN YEASTS FOUND IN FERMENTED HONEY[1]

By GEORGE E. MARVIN, *University of Wisconsin*

ABSTRACT

The fermentation of extracted honey after canning is a cause of much worry on the part of Wisconsin beekeepers, when a part of the crop has to be held over from one year to another. It was formerly believed that only unripened honey would ferment and sour. Thoroughly ripened honeys with a moisture content between 14 and 20% have been found which contain the potential elements for souring. Upon storage and with subsequent granulation of the honey, fermentation may begin.

Several yeasts in the group zygosaccharomyces have been isolated and determined as new to science. Of the three known species, only one has so far been found.

INTRODUCTION

The fermentation of extracted honey after canning is the cause of much worry on the part of beekeepers in all parts of the United States, whenever a part of a crop must be held over during a period of from six to eighteen months. In such instances, it is usually considered that the honey was not properly prepared by the beekeeper, and perhaps it had been extracted before being thoroughly ripened by the bees. However, many recent cases have come to our attention, which show that, even though the beekeeper may have done everything possible in the way of preparing his honey for market, fermentation has appeared after a number of months in storage. The exact details of the cause of fermentation have not yet been completely worked out, but a complete investigation of the effect of storage upon the keeping qualities of honey is now under way at the Wisconsin Agricultural Experiment Station under the direction of Professor H. F. Wilson, of the Department of Economic Entomology, and Dr. E. B. Fred of the Bacteriology Department.

At the present time, I am presenting one phase of this problem, upon which I have been working during the past year. This phase consists of a study of the occurrence and characteristics of certain yeasts found in fermented honey. During the course of the work, five different strains of the yeasts have been cultured from fermented honey, and sufficient work has been done with the characteristics of these five strains to show that each one is distinct, and no doubt in the course of future work, additional distinct strains will be found.

Although some work has been done on these yeasts in European countries, there are no published records to show that any American investigator has made an attempt to study these organisms.

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[1] Contribution from the Departments of Entomology and Bacteriology of the University of Wisconsin.

HISTORICAL

Shutt in 1902 observed that honey from uncapped or only partially capped combs is higher in moisture and is of decidedly poorer keeping qualities than honey from fully capped combs.

A. J. Cook, in 1908, wrote, "All sugars if very dilute are the best pasturage for micro-organisms. Vinegar is the result of such action. Our unripe honey illustrates the same truth when it sours. In the action of these germs, not only is acetic acid produced, but, as surely, carbon dioxide gas. Barrels of unripe honey are likely to burst from this cause, as I once witnessed in the warehouse of Newman in Chicago."

Klöcker, about 1904, isolated *Zygosaccharomyces priorianus* from the bodies and honey sacs of honey bees. The cells of this organism are of various forms; round, oval, or elongated, and firmly attached together so that the sedimental yeast forms a coherent mass. The spores are round or oval and generally 2-4 in a cell. The species ferments glucose, levulose, maltose and sucrose, but not lactose.

Nussbaumer, in 1910, isolated two species of *Zygosaccharomyces* from fermented honeys. Species A ferments glucose, fructose, maltose, mannose, sucrose, dextrin and galactose. It ferments xylose and raffinose feebly. Species B ferments glucose, fructose, mannose, sucrose, dextrin and galactose. It ferments xylose feebly.

Richter, in 1912, isolated *Zygosaccharmyces mellis acidi* from fermented honey. During fermentation, alcohol and acid were produced. This species ferments glucose, fructose and sucrose strongly and galactose feebly.

Root, H. H., in 1918, wrote, "Probably not one beekeeper in a hundred can tell by the taste or appearance whether extracted honey, when put in cans and kept in a dry place, is proof against fermentation. It is impossible for all honey to find its way to the home of the consumer within six or even nine months from the time it is produced. The supreme test comes when honey is kept until January, February and on into March and April. Honey which was granulated hard when first bought, was kept in a warm, dry room, fermented and expanded the cans so that they burst. This honey was not extremely sour to the taste and yet there was a very perceptible flavor of fermentation, practically ruining the whole lot. Someone extracted the honey too green. The mere fact that honey is granulated hard at first is not by any means proof that it is entirely ripe. This honey was apparently all right in November."

T. Jimbo of Japan, in 1926, says, "I have investigated the nectar of 273 flowers of 23 species of plants. Almost all of them were infected with yeasts which could be distinguished in 23 forms, 10 forms of which were rare."

Grüss, in 1927, isolated what he called nectar yeasts from the flowers of an Alpine plant naming them *Anthomyces alpinus* and *Microanthomyces alpinus*. Both yeasts ferment glucose and fructose, but Anthomyces ferments the latter more rapidly than the former while Microanthomyces acts conversely. Giant colonies formed on agar by the latter are larger than those of the former.

MATERIALS AND METHODS

SAMPLES OF FERMENTED HONEY. *Strains I and IA.* These strains were isolated in March, 1926, from honey which was produced in the University apiary. It had been extracted in August, 1925, strained while cold and allowed to stand in a large closed tank in the extracting room. By the first part of September, this honey had partially crystallized, but would ooze slowly from the honey gate on opening it. It was then allowed to run into wax paper cartons for hardening. Ordinarily, honey becomes quite solid within a month, but, instead of hardening in the cartons, it became more liquid and bubbles of gas were observed by November. Three cartons full were emptied into each of two five pound pails, with the covers put on in the ordinary way. Before long, a rounding of the bottoms of the pails was observed, showing that gas was held within under pressure. These pails were selected for study and from these samples, the first two strains of yeast were isolated.

Strain A. This yeast was isolated from a ten pound pail of honey which was sent in for the Miller Library Fund in October, 1926. The pail was allowed to stand at room temperature for some time. The honey was crystallized and fermentation became apparent from the odor and scum on the surface.

Strain B. This yeast was isolated from a six pound square can of honey sent in for the Library Fund in November, 1926. The honey was of amber color and semi-solid when first received. Due to the odd sized container, the honey was not sold, hence remained in the office for several months. The cover was loosely on and before long, honey began to be forced out. On examination, we found that fermentation had set in. As fermentation continued, the honey became thinner until it could be poured from the opening quite readily.

Strain C. This yeast was isolated from fermented honey brought to the office by a beekeeper in the city. He did his extracting as usual in August, 1926. The honey was strained while cold and put in a storage tank. Some was drawn off from time to time, heated and put in jars and containers for sale. As the season advanced, there were still several hundred pounds in the tank and fermentation became apparent. The beekeeper brought a pound glass jar of it to the office. Bubbles were noticed all through the sample and it looked as if there was a rapid fermentation going on. The sample was crystallized, but as the fermentation advanced, the honey became more liquid.

The Isolation of Yeasts

The Media. Some difficulty was encountered at the beginning of the problem in getting a honey medium upon which to grow the yeasts isolated from fermented honey. Finally, a medium was made up of yeast water, agar, and honey on which the yeasts thrived.

This medium was made by dissolving washed agar in the yeast water and adding honey. The following proportions were used: yeast water—4 parts; honey—1 part, and 3 per cent washed agar. This medium was then tubed for slopes and petri dishes or put in 100 cc. flasks for giant colonies. They were then sterilized for 30 minutes at 15 pounds pressure. If sterilization takes place longer, the honey will caramelize and turn dark. Also, due to the acid contend of the honey, the agar will be hydrolized to some extent and then the medium will not harden.

Methods Used in Plating. Three different methods were used in isolating the organisms from a sample of fermented honey—

1. The honey-yeast water-agar medium was melted and cooled to 45° C. A loopful of the fermented honey was added and after thoroughly mixing, the medium was poured into a sterile petri dish and allowed to harden.

2. The medium was liquified, poured into a sterile petri dish and allowed to harden. The hardened surface was then streaked with a needle which had been inserted previously into fermented honey.

3. Four or five loopsful of fermented honey were put into a tube of sterile water. This was shaken so as to dissolve the honey and the tube was then centrifuged. The clear liquid on top then was drawn off. A loopful of the heavier material on the bottom was used as an inoculant and then the first procedure was followed.

Incubation. The petri dishes thus inoculated with samples of fermented honey by any of the foregoing methods were placed under various conditions to incubate.

1. At room temperature and at 82°F.
2. In Anaerobic jars at room temperature and 82°F.
3. Under vacuum at room temperature and 82°F.

Within five or six days, those dishes incubated at room temperature and also within two or three days the ones at 82°F. began to show growth. Small round white colonies became visible. A microscopic examination proved these colonies to be yeasts. No growth at all was noticed on the plates incubated in anaerobic or vacuum jars.

These operations were repeated many times, using different samples of fermented honey from various sources and each time yeast colonies were the only organisms that grew. Thus, we can safely say that the fermentation or souring of honey is undoubtedly caused by yeasts. So far in the work, five strains of yeasts have been isolated from fermented samples of honey. All are able to grow in very concentrated solutions of honey. Further analytical methods, however, will have to be employed before we can state definitely whether these strains are entirely distinct species.

Giant colonies have been grown from each yeast. In raising giant colonies, 100 cc. Erlenmeyer flasks were used. Fifty cc. of honey-yeast water-agar medium was put into each flask, after which they were plugged and sterilized. A sterilized needle was used to fish off a colony from the petri dish and the center of the hardened sterile medium was then touched with this needle. Within a day or so growth began to appear. In about two months, the colonies would be from one to one and one-half inches in diameter.

This procedure was followed in raising several hundred colonies, and out of the whole number only five distinct forms appeared which are shown in the following plates.

EXPERIMENTAL RESULTS

1. Liquid samples of honey, when inoculated with fermentation yeasts, have a tendency to granulate or crystallize. Crystallization seems to be bound up some way or another with fermentation. More work will have to be done on this before any conclusions can be drawn.

2. All of the five yeasts isolated from fermented honey, ferment glucose, levulose and mannose. Strains A and C ferment sucrose, while the latter also ferments maltose.

The following sugars were used:—

A. Pentoses: xylose
B. Hexoses: glucose, galactose, mannose, levulose
C. Disaccharides: sucrose, maltose, lactose
D. Trisaccharides: raffinose, melezitose

The fermentation was carried on in test tubes with 10 cc. of a 10% sugar solution in each tube.

3. The five strains of yeast can be separated into three groups relative to ring formation in a flask of fermenting wort. Strain A forms a very light ring; Strains 1, 1A and B form a medium heavy ring while strain C forms a very heavy ring.

4. Moisture determinations were made on various samples of fermented honeys and on one unfermented. The crystals and liquid part were separated and determinations made on each.

Sample I—A fermented honey which was granulated—26.6%.
Sample II—A liquid sample fermenting in the comb. The cells were uncapped—28.5%.
Sample III—Granulated, fermented honey—20.7%.
Sample IV—Unfermented—Coarse crystallization—16.3%.
Sample V—The crystals separated from Sample IV—11.75%.
Sample VI—The liquid part separated from Sample IV—20.8%.

5. From experiments carried on so far, it appears that yeast cells are found in almost all honeys and when they are diluted, fermentation sets in. We know yeasts are very widely distributed everywhere in nature and apparently they find their way onto the pollen and into nectar and are so carried to the hive by the bees. A recent experiment shows that pollen stored within the hive contains large numbers of yeasts.

On microscopical examination of honeys, many grains of pollen are apparent. During the process of the ripening of honey, the yeast cells are not killed and are so found in most honeys in a dormant state. When

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PLATE 7

STRAIN I.—1, shows the natural size of a two months old giant colony, reared on a 20% honey medium. See page 365 for isolation; 2, the same colony enlarged nearly two diameters.

STRAIN IA.—3, shows the natural size of a two months old giant colony, reared on a 20% honey medium. See page 365 for isolation; 4, the same colony enlarged nearly two diameters.

STRAIN B.—5, shows the natural size of a two months old giant colony reared on 20% honey medium. See page 365 for isolation; 6, the same colony enlarged nearly two diameters.

PLATE 8

STRAIN A.—1, shows a two months old giant colony enlarged nearly two diameters; 2, colony three moths old enlarged nearly two diameters.

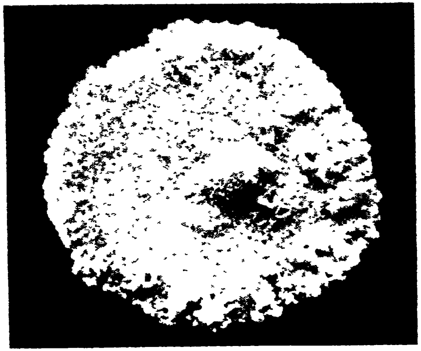
STRAIN C.—3, shows the natural size of a two months old giant colony reared on 20% honey medium. See page 366 for isolation; 4, the same colony enlarged a little less than two diameters.

Plate 7

1

2

3



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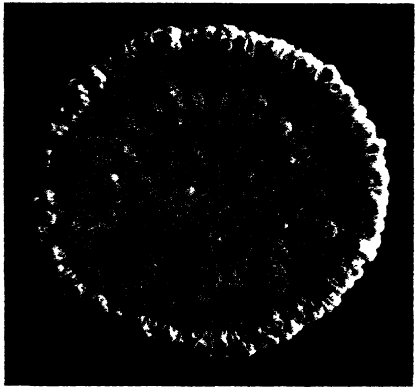

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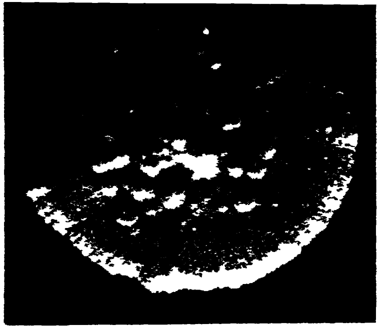

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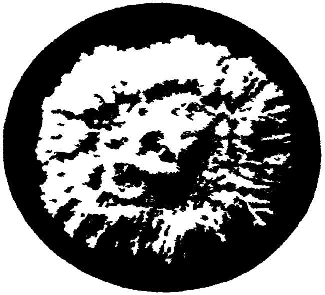

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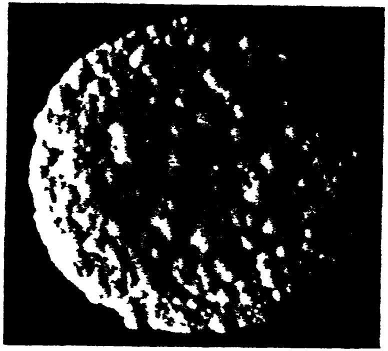

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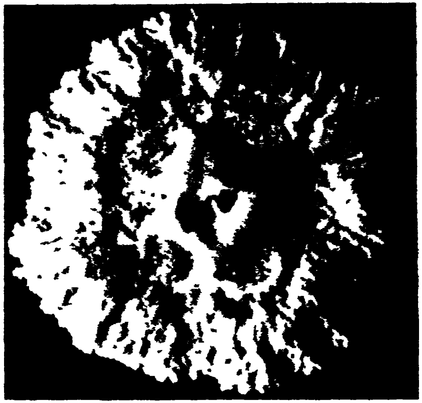

4

the right conditions are brought about in the honey, the yeast cells begin to multiply and so cause the honey to ferment.

6. Honey heated to 160°F. does not ferment, due to a killing of the yeasts. In Plate 10, the two flasks on the left were heated to 160°, while the two flasks on the right were kept as checks. Within two months, an active fermentation had set in for those not heated. These samples were extracted early in the season, before the bees had fully capped the cells and had sufficient time to ripen the honey. This also shows that yeast cells are present in honeys when taken from the hive.

7. Fermentation can also be prevented by keeping honey at 52°F., for at that temperature the yeasts will not bud or grow.

8. Pollen stored in the combs within the hive contains large numbers of yeast cells, so if much pollen is found in the honey, yeast cells are almost certain to be there, also.

How Yeasts are Studied

The various yeasts are studied in water mounts stained with Rose Bengal. Vaseline is placed around the sides of the cover slip to prevent drying out.

Summary

Fermentation of honey is caused by yeasts. Yeast cells appear to be in most honeys and when osmotic pressure on the cells is decreased, they begin to grow, causing a souring or fermenting. Ethyl alcohol and carbon dioxide are given off in the process. By heating honey to 160°F., and pailing while hot fermentation can be completely prevented. Honey which is thoroughly capped is not proof against fermentation.

Fermentation of honey is a very serious problem among Wisconsin beekeepers. Up to the present time, only three species of honey yeasts have been described, all of these in Europe.

In the present work, we have found what appears to be five distinct strains or species. These five strains have been indicated by the following numbers—

Strain 1 —Plate 7, fig. 1, 2
Strain 1A—Plate 7, fig. 3, 4
Strain A —Plate 8, fig. 1, 2
Strain B —Plate 7, fig. 5, 6
Strain C —Plate 8, fig. 3, 4

CHAIRMAN MILLEN: The paper we have just listened to opens up a wonderful possibility for the bee-keeper. I believe I am right in saying, generally speaking, the practical bee-keeper himself has not appreciated the seriousness of the fermentation of honeys in the past years, for the reason that until the last few years we have had few organizations which would hold honey off the market for a certain length of time.

This question of fermentation, as Mr. Marvin said, is important in Wisconsin, and I assure him it is equally important in Ontario. We did not realize the serious condition until the last three years. Since that time we have held over thousands of pounds of honey in a warehouse for four, five or six months, depending upon conditions. It is remarkable the amount of honey that has fermented.

This also brings out another very valuable point, showing the need today for research on a good many problems which the bee-keepers have, and which it is impossible for the practical bee-keeper to find out about himself.

F. C. PELLETT: What did he find by heating the honey? Would it keep permanently, or would the yeast develop later?

GEORGE E. MARVIN: In the last year the yeast has not showed up. We have only treated it two years.

CHAIRMAN MILLEN: Is there any other discussion? If there is no other discussion, before the next paper is presented, I should like to appoint: W. J. Nolan, G. E. Marvin and E. J. Anderson as the Nominating Committee, and we will be very glad if that committee will meet as soon as possible, and bring in their recommendations before the close of the meeting.

MR. F. C. PELLETT: Mr. Millen will read his paper.

PLATE 9

1.—Two samples of fermented honey. The honey at first was all candied and as the fermentation worked down, the honey became liquified. There is a heavy scum on the surface which contains large air bubbles of carbon dioxide. If fermented honey is in a tin container, the gas under pressure causes the top or bottom to swell out.

2.—There are two simple sugars found in honey; when it crystallizes it is the dextrose which granulates and the levulose which remains liquid. Upon separation, the moisture content is found to be considerably higher in the liquid part than in the granulated part.

PLATE 10

HEATING HONEY PREVENTS FERMENTATION

The above four flasks contain samples of the same honey. The two flasks on the left have been heated to 160°F. in a water bath. Those on the right have not been heated and after two months, fermentation set in, showing that yeast cells were present in the honey.

1

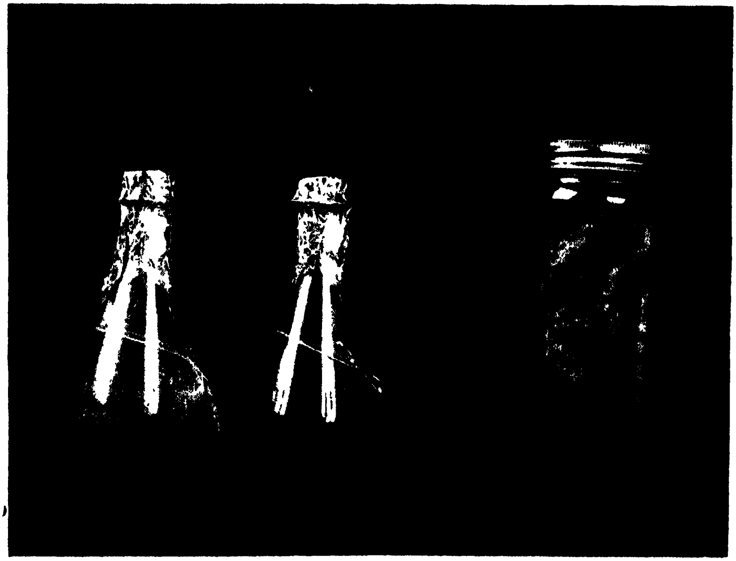

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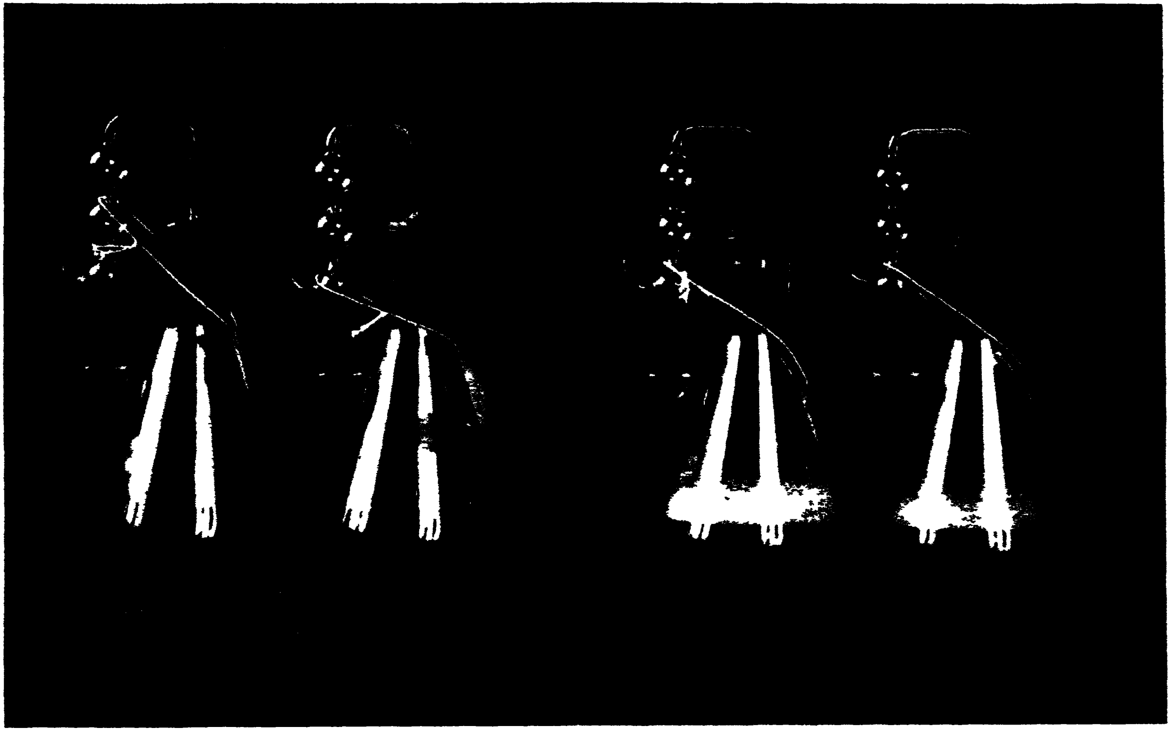
Plate 10



AREA CLEAN UP OF FOULBROOD

By F. E. Millen, *Guelph, Canada*

This paper deals entirely with American foulbrood. Apiary inspection for the control and eradication of American foulbrood has been carried on for many years in some states of the Union and since 1890 in the province of Ontario.

The discussion of foulbrood in beekeepers' conventions is probably the oldest and most discussed of all subjects relating to the keeping of bees. "Where there is smoke there must be fire" and those engaged in apiary inspection, in those states or provinces where the keeping of bees has been practised for many years, fully appreciate the destruction and loss occasioned by American foulbrood.

Apiary inspectors and those in charge of apiary inspection realize that the control and final eradication of American foulbrood is a very serious problem which calls for constant vigilance, a great deal of hard work and very thorough organization.

The province of Ontario is a typical example of a number of the states and my experience in Michigan and Iowa proves to me that in these cases, at least, one finds the same conditions which may be met with similar remedies. While the subject of foulbrood is perennial, the laws relating to its control have undergone changes during the last seven years which have materially helped the situation. The results show that, however serious and prevalent, this foulbrood can be eliminated to the point where it ceases to be a serious menace to the beekeeping industry and can actually be eradicated from a given territory provided the law is clear and the majority of the beekeepers desire the eradication of this disease.

Foulbrood acts, in the states and provinces, vary and in some cases the efforts to eliminate American foulbrood are not meeting with success. It would aid the earlier eradication of this disease if the laws relating to the control of foulbrood were identical. This however, must take time because after all the beekeepers themselves must be brought to the point where they see the need for this action.

Having had charge of apiary inspection under both educational and regulatory forms of Foulbrood Acts I believe that neither one of these forms alone is as good as a combination of the two. The educational form of the act does not give the apiary inspector much opportunity to control foulbrood or prevent its spread. Money expended therefore loses much of its value because of the fact that most beekeepers are human, and if allowed, try to minimize their original loss by salvage. In many instances the salvaged material means a much heavier loss to the individual before American foulbrood is eradicated from the infected apiary, besides which it often spreads to nearby clean apiaries. With the foulbrood Act a regulatory one only, much ill feeling is aroused among the beekeepers and the apiary inspection is unpleasant, very costly and does not secure the most desirable results. I have found that an act which contains the educational features with certain of the regulatory clauses included, gives the best and most lasting results.

After all a Foulbrood Act is only a means to an end and the methods of carrying out the provisions of the act are extremely important. Experience shows that before the act can be successfully operated, those in charge of apiary inspection must bring about a receptive attitude in the minds of the beekeepers themselves. The organization of county beekeepers' associations provides an excellent means to accomplish this end. Experience proves that if the beekeepers can be shown the good which will result from a certain form of apiary inspection and their enthusiasm leads them to petition the department to carry out the act, the best results are obtained.

Foulbrood acts should contain among other essentials, registration of beekeepers, necessity of securing permit before selling or moving colonies or used apiary supplies, a quarantine clause and a stiff penalty for the occasional bad man among the beekeepers.

REGISTRATION OF BEEKEEPERS. One of the important features of the area clean up of American foulbrood is to be certain that every beekeeper in any given area must be visited by the inspector and his colonies and equipment thoroughly inspected. We have found that in most diseased areas there are 1 or 2 beekeepers who are usually the cause of the spread of disease and should one of these be missed, the inspection work already accomplished is nullified. To make registration as nearly complete as possible a registration fee is also desirable for a double purpose, first a number of men are keeping bees who have absolutely no interest in the business. These men rarely touch their colonies, know nothing of the brood diseases and generally are a menace to all other beekeepers. In these cases a registration fee will cause them to dispose of their colonies and equipment, a desirable feature from all viewpoints. It also seems unfair that the government should advance all the money for apiary inspection work in any given state or province. The registration clause must be enforced to be of practical value, this of course must not be done until beekeepers have had a fair chance to comply with the provisions of registration. In Ontario we believe there are 9,000 or more keeping bees. The registration fee is $1.00 per apiary, regardless of the number of colonies, with a maximum of $5.00 for any one beekeeper. The first year nearly $4,000 was secured from registration, the second year over $5,000 and the third year over $6,000. At the end of the 3rd year prosecutions were commenced against those not registered and the registration receipts immediately increased to a very appreciable degree and we hope that by the end of the 4th year registration will be much more complete than formerly. The requirements for registration also give valuable statistics as to the number of colonies and amount of honey produced in any given county or province. We are finding registration of considerable aid in our apiary inspection work.

Every foulbrood act should contain a clause making the securing of a permit essential before colonies or used apiary supplies can be moved, sold or given away. Robbing excepted, we find that the movement of colonies and infected material is the greatest, and most dangerous source of the spread of American foulbrood. The damage caused is often much more severe than in robbing, because the disease is often introduced to clean areas. A penalty must be added to this clause and applied in flagrant cases.

QUARANTINE CLAUSE. This appears to be a means to an end and where a county is free from American foulbrood there is no better way of keeping it clean than to prohibit the entry, into the county, of any colonies of bees or used apiary supplies. Package bees under supervision are excepted. We find the quarantine clause very helpful, especially where the beekeepers in the county are well organized, once beekeepers feel that their vicinity can be kept free from foulbrood, if other colonies and used supplies are excluded, they will cooperate in every way and information is secured at once if the quarantine is broken.

Every foulbrood act must contain penalties if American foulbrood is to be eradicated. While the penalty is seldom needed, there are cases where the infliction of a fine has a wholesome effect and tactfully applied it makes for greater efficiency in apiary inspection.

Area clean up of American foulbrood does not give results unless the beekeepers in the county or area demand it. This is where the apiary inspector has his chance and it is surprising what can be accomplished by wise propaganda. Once the beekeepers are brought round to the point where they want this disease to be cleaned out it is only a matter of time until it becomes a fact.

In area clean up the inspectors must be imbued with the right spirit. Inspectors must possess a great deal of personality and must at all times treat every beekeeper exactly alike, regardless of whether the beekeeper owns 1 or 1,000 colonies. This treatment gradually earns respect and is worth a great deal in future work.

The day for treating colonies of bees infected with American foulbrood should be a historical fact only. All the evidence I have been able to gather shows that the treating of colonies infected with American foulbrood proves a boomerang. There are exceptions, but while beekeepers are allowed to treat colonies, once the inspectors find the disease, we cannot hope to eradicate the disease.

Conditions are vastly different now compared with a few years ago. Today the beekeeper can minimize his loss by treating his surplus combs and equipment so that the repetition of the disease is avoided. Apiary inspection under the area clean up plan also differs from the older form of inspection. With the area clean up plan in operation, the work must be thorough and must be repeated, even after the area is thought to be clean. The beekeepers in the area must also realize that unless the greatest cooperation with the inspection service is continued, the area may become reinfected.

We owe a debt of thanks to Wisconsin for their early efforts in the area clean up of American foulbrood and hope their work will be the means of showing other states and provinces that American foulbrood will always be with us if we believe it cannot be eradicated, on the other hand our experience shows that properly conducted the area clean up will eradicate this disease and make beekeeping that much more profitable for the beekeeping industry.

CHAIRMAN PELLET: Mr. Millen has opened some very interesting subjects for discussion. Does anyone wish to add anything to this paper?

MRS. GRACE ALLEN: What about honeys in infected areas that are being cleaned up? You keep out the infected bees and supplies, but if you allow the honey to come in it does not help matters.

F. E. MILLEN: We are destroying brood chambers and contents. Everything within that colony, contents of supers and brood chambers are destroyed.

MRS. GRACE ALLEN: I mean that somebody from outside might ship in some honey and put the infected honey on the grocer's shelves.

F. E. MILLEN: Take the city of Toronto, we have not found any more, in fact we have found a less percentage of American foulbrood immediately in the vicinity of Toronto than we have a number of miles outside. That is considering the same number of colonies of bees. We find less disease, if anything, around the city of Toronto, than we do in points outside. We have not found that trouble in Ontario.

CHAIRMAN PELLETT: Is there any further discussion?

F. M. BROWN: The *Bacillus larvae* supposed to cause American foulbrood is killed by a lengthy period of time in honey. The maximum amount of time it can maintain its virulence in honey is about 28 days. Usually at the end of 14 days, it is no longer active. That probably would explain how contaminated honey will sterilize itself.

Mr. Millen resumed the Chair.

CHAIRMAN MILLEN: I think Mr. Nolan will give a summary of the next two papers.

W. J. NOLAN: I am not going to read the papers. I have a brief summary of two new diseases found in this country. Those of you who were present at the Memorial meeting in Ohio heard Dr. Trail of Germany describe the amoeba which has been found in Germany in the organs of the honey-bee. Up to that time this organism had never been seen in this country. It so happened that last spring when Mr. Bulger was examining some bees he suspected, he got some specimens and submitted them to Dr. White for examination. So far no further investigation has been made on this particular organism, but it seems that it is not to be taken seriously, at least at the present time.

I have one slide which shows this organism. This has been enlarged 40 times. As I said, so far no one considers this disease of any particular economic importance.

MALPIGHAMOEBA (PRELL) IN THE ADULT HONEYBEE FOUND IN THE UNITED STATES

By J. W. Bulger, *Assistant Apicultural Physiologist, Bureau of Entomology, United States Department of Agriculture*

Abstract

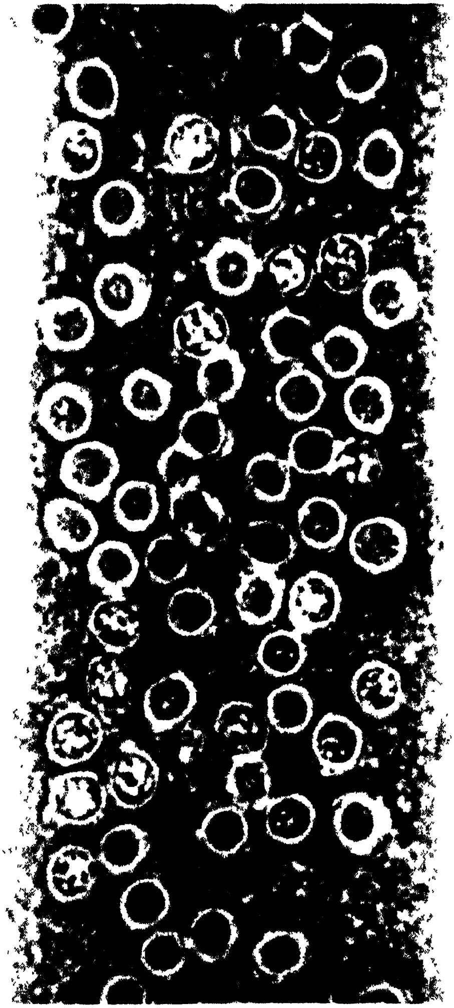
An organism causing the "so-called" Amoeba Disease in the adult honeybee was found early in February, 1927 in two colonies of bees in the apiary of the office of Bee Culture Investigations, Washington, D. C. So far as the writer knows this is the first report of the occurrence of this disease of the honeybee in the United States. The disease is not thought to be of very great economic importance.

In the course of some physiological investigations during the winter of 1926–27 cysts of an organism which develops within the Malpighian tubules of the adult honeybee were found in two colonies of bees in the apiary of the Division of Bee Culture Investigations at Washington, D. C. The writer (1) made a preliminary announcement of this discovery in the Official Record of the Department of Agriculture, July 20, 1927.

Some time after the above-mentioned experiments were started, the writer noticed that the rate of mortality in colony No. 61 was very much greater than that in any of the other seven colonies under observation. In order to determine if this high death rate could in any way be attributed to *Nosema apis*, one of the prevalent diseases of the adult honeybee, examinations for it were made in chilled and fallen bees collected from the bottom-board. Nosema was found to be present in the intestine of practically every bee examined. After having found one of the experimental colonies affected with Nosema the writer decided to look for this disease in the other colonies. Only one of them (No. 63) was at that time found infected.

On January 31, 1927, while looking for Nosema, the writer found cysts of an organism in the Malphigian tubule of a bee from colony No. 68. Preliminary studies caused the writer to suspect that this organism was that of the so-called Amoeba disease reported in Europe. Realizing that the amoeba had only been found in conjunction with Nosema, bees were examined daily from colonies Nos. 61 and 63 which had previously been found to be infected with Nosema. On February 3, cysts of the same organism were found in colony No. 61. They were, however, never found in bees from colony No. 63, although it was heavily infected with Nosema and died about the last of March.

It is also worthy of note that Nosema was not found in five samples of bees taken from the bottom-board of colony No. 68 at various



A malphigian tubercle of the adult honeybee showing cysts of the organism causing the "Amoeba disease" (Prell) of the adult honey bee.

intervals between the last of January and the 10th of March. On March 10th, or nearly 6 weeks after the cysts had first been seen, Nosema was found in this colony. The infection, however, was rather light. So far as the writer knows, this is the first report of the occurrence of the amoëba without the concurrent presence of Nosema.

What is probably a vegetative stage of this organism was identified early in April by Dr. G. F. White of the Bureau of Entomology. This form had also been seen by the writer in the course of his studies on infected specimens. This form of the organism, however, somewhat resembles the cysts except for size and the fact that it does not have a double walled body.

Miss Catherine Lucas, on a traveling fellowship from the University of London, in connection with her study of the amoebae of insects at Johns Hopkins University, spent most of the months of April and May 1927 at the Office of Bee Culture Investigations and likewise found the two forms of this organism in bees from the above-mentioned colonies.

In the more heavily infected bees most of the Malpighian tubules were completely packed with the globular to ovoid, almost transparent, cysts. These tubules were also somewhat distended, glassy in appearance, and easily broken. In the first case of infection found and in many of the heavier infections little was left of the tubule except the outside membranous wall. In such cases the epithelial cells of the tubule apparently had been considerably altered by the organism.

During the course of the writer's studies a number of slides were prepared by making smears of the tubules containing the cysts and then staining with Mann's ameboid stain (2)[1]. In general, the appearance of the stained preparations corresponded very well to those described by Prell (3).

In the accompanying plate is shown a photomicrograph of a section of the Malpighian tubule. Numerous cysts are shown in the lumen of the tube. Measurements made from prepared sections showed the cysts (in 58 measurements) to vary from 4.76μ to 6.83μ with an average of 5.67μ. Prell (4) gives their size as from 5μ to 7μ.

Doctor White and Miss Lucas, who have studied this organism both in fresh and in stained preparations, are of the opinion that this organism is none other than the one for which Prell (4) suggested the name *Vahlkampfia* (*Malpighamoeba*) *mellificae*.

It may be of some interest to note that the colony No. 68 is of Italian stock. At present the writer does not have information as to when the present queen was introduced but it is certain that she is not an imported queen. Colony No. 61 was an American-reared Italian colony requeened on the 23d of August, 1927, with an American-reared Carniolan queen.

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[1] Reference is made by number (italic) to "Literature cited," p. 379.

After January 31 and February 3, the dates on which the amoeba was first found in these two colonies, the cysts were found at every examination of the bees collected from the bottom-boards of the two infected colonies. While no definite percentage counts were made, in general the writer would say that from January 31 to about the 1st of April cysts were found in approximately 1 in 10 to 15 of the bees examined. In looking for the cysts the writer used only the chilled and weakened bees that had fallen to the bottom-board. Doctor White began working with this organism early in April and in his studies in which he used the pollen carrying bees of colony 61 infection was about as prevalent as the writer had found it in bees collected from the bottom-board. At the same time he did not nearly so frequently find cases of infection in colony No. 68. On May 15 the infection seemed to have almost disappeared and was found only with great difficulty in either of the colonies.

Colony No. 61, which was the most heavily infected with Nosema, as well as with ameoba, became very weak by the 15th of May and had to be helped with brood from other colonies. On the other hand, colony No. 68 seems to have withstood the diseases very well and on May 13 was normally strong.

According to Prell the amoeba was first seen in Europe in 1916 by Maassen who made further studies on it in 1919 and 1921. Morgenthaler has reported this organism several times (1920, 1922, 1924, 1925). Prell studied this organism in 1926 and decided that it belonged in the same group as the "hay amoeba" (genus Vahlkampfia) but points out that the pointed structure of the pseudopoda, described and figured by Maassen, seem to indicate that it at least occupies an isolated position in the genus and probably deserves to be placed in a separate one. Since no amoeba in the honeybee had been previously known he suggests (4) the name *Vahlkampfia* (*Malpighamoeba*) *mellifica* n. sp.

Very little is known of this organism and practically nothing of its economic importance. From its limited occurrence in the infected colonies in the apiary of the Division of Bee Culture Investigations and the fact that, as Prell noted in Europe, it seems to disappear early in the summer, it is doubtful if it is of much economic importance. However, this point has not yet been determined.

It is a very interesting organism and should be a fruitful one for further study. The writer does not feel that the occurrence of the

Amoeba disease in this country should excite much alarm. However, bee men and biologists should be on the alert. It is probable that this organism can be found if looked for in material of the proper sort in other apiaries throughout the country, and it may be found to be of considerable economic importance.

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A SEPTICEMIC CONDITION OF ADULT BEES

By C. E. BURNSIDE, *Assistant Apiculturist, Bureau of Entomology,*
United States Department of Agriculture

ABSTRACT

A heretofore unrecognized organism, *Bacillus apisepticus*, is shown to be the cause of a fatal septicemic condition of adult bees. Experimental results obtained thus far seem to indicate that the presence of external moisture aids in the transmission of the disease.

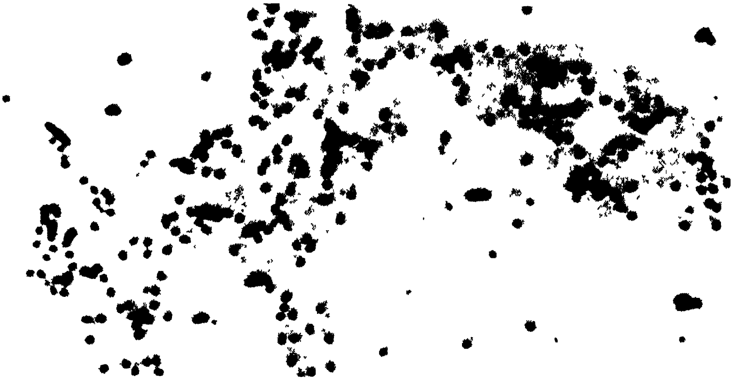
In September, 1927, the writer's attention was attracted by the large number of adult worker bees dying in and about a certain hive in the apiary of the Bee Culture Laboratory at Somerset, Maryland. It was observed that a few of the infected bees crawled, of their own accord, from the hive, but the greater number were carried out by other workers during the early stages of infection. This condition existed until the first week of October, when it subsided without treatment. Dissection and microscopic examinations of dying and dead bees eliminated all the known ailments of adult bees (Nosema disease, Isle of Wight disease, Mycosis, Amoeba disease and the condition known among beekeepers as dysentery) as being the cause of the trouble. Bacteria in large numbers and in pure or apparently pure culture were encountered in the blood of most of these abnormal bees. An examination of individual bees, showing similar symptoms taken from several other colonies in the apiary, established the presence of this disease in those colonies also, but in a lesser degree. Although the writer was unfamiliar with this organism, he recognized its similarity to the organisms causing cutworm septicemia and hornworm septicemia (3, 4). To establish the fact that it is the exciting cause of the disorder, apparently healthy bees were inoculated by a needle dipped into the blood of sick or dead bees. They soon became infected and a mortality of 100 per cent usually resulted. Check bees punctured with a sterile needle or with a needle dipped into the blood of healthy bees were not noticeably affected. Because of the constant protection afforded by the exoskeleton, infection by this method could scarcely occur in nature.

That adult bees suffer from systemic infection by bacteria seems to have been suspected only by Cheshire (2). He found two rod-shaped organisms, varying much in size, in blood smears of bees. These organisms, which were incompletely described and figured, were thought to have been the cause of a "destructive attack." Concerning two other organisms obtained from the blood of diseased queens, Cheshire writes of one as follows: "In a large apiary, a queen of very unusual size but with relatively small legs was found to be too weak to continue on the comb, and was literally scarcely more than a bag of micrococci, the whole body being completely broken down. Upon touching her side with the point of forceps, with the idea of commencing a dissection, a thin, milky fluid escaped." (His figure of the organism shows numerous coccoid and ovoid forms.) Of the other he says, "This strange organism was found in millions in the blood of a queen sent to me with a statement, that although not old, she was useless, as she scarcely laid at all. These organisms clearly multiply by fissuration, and carry a thick envelope, while within they have darker cross markings difficult to define." Cheshire's descriptions and illustrations are insufficient to identify the organisms; consequently one can not know, whether any of those described by him are identical with the one under observation by the writer.

Bacillus paratyphus alvei, named and described by Bahr (1) as the cause of intestinal disturbances in adult bees, was recovered by him from the blood of infected bees. He apparently did not consider this fact of importance, since he made no further mention of it, nor did he associate the organism with a septicemic condition of adult bees.

The name *Bacillus apisepticus* is used for the organism encountered in this disease. Besides being found in the blood of bees, this organism has been recovered in abundance from humus soil in the neighborhood of infected colonies.

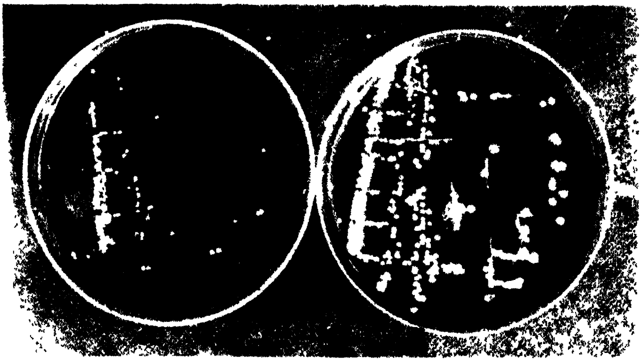
1.—Bees dead of septicemia, dismembered by slight handling.



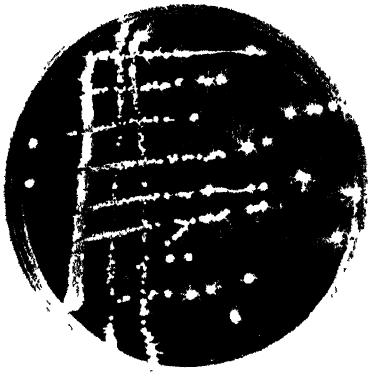
2. *Bacillus apisepticus* from an agar culture.

3.—Stained smear of blood of bees dead of septicemia.

Plate 13

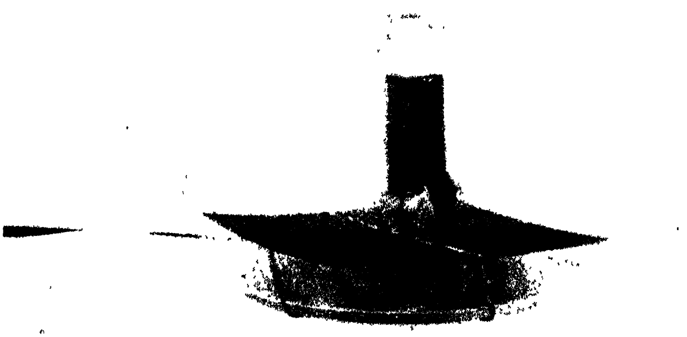


4.—Colonies of *Bacillus apisepticus* on agar; *a*, 24 hours old; *b*, 60 hours old.



5.—Arborescent growth of *Bacillus apisepticus*

6.—Old culture of *Bacillus apisepticus* on agar



7.—Type of cage for experiments with caged bees.

Bacillus apisepticus n. sp. This organism grows readily on the media ordinarily used for bacteria. Growth occurs under a wide range of temperature. The temperature of the room and a temperature of 36°C. have been used most for culturing.

Morphology. The organism from agar is rod-shaped, varying considerably in length. The shorter rods appear almost spherical. The greater number are oval; short rods with rounded ends are plentiful, and longer rods frequently occur in chains. The spherical forms measure approximately 0.6 to 0.7μ; the oval and elliptical forms 0.6 to 0.7μ by 0.8 to 1.5μ. The rods are often 0.6 to 1.0μ by 1.5 to 3μ; longer rods are not uncommon. In bouillon the dimensions are slightly greater than on agar, and the proportion of rods is slightly greater. No spores have been observed; see Figs. 2 and 3.

Motility. The organism is actively motile, the movements being progressive and whirling. The ends often progress in a spiral course about a more or less central axis.

Staining Properties. The organism stains readily and is gram negative.

Agar Plates. The colonies develop rapidly on agar plates. The outline is at first entire but often becomes amoeboid. (See Figs. 4, 5, and 6.) The colonies are slightly elevated and granular and their surface appears moist and glistening. They are grayish white by reflected light and bluish by transmitted light.

Agar Slant. A slightly raised grayish white growth occurs along the inoculated surface.

Gelatin Plates. At room temperature, after 24 hours, the colonies are surrounded by a depressed area of liquefaction which increases with the growth of the organism.

Gelatin Stab. After 24 hours at room temperature a white line of growth is present. Liquefaction is first noticed at the surface. The liquefied portion is at first slightly depressed; later it becomes infundibuliform.

Potato. A grayish-white growth appears which covers the surface. Gas is formed. The potato becomes brownish, the color deepens, and finally becomes almost black.

Bouillon. Within 24 hours the medium is cloudy throughout. Considerable sediment is formed after 48 hours. A ring forms which clings to the sides of the glass. A thin pellicle may form.

Milk. Within a day a coagulum is present which is slowly digested.

Litmus Milk. The medium becomes slightly acid within two days. The color is discharged.

Carbohydrates. Gas and acid are produced in dextrose and sucrose. An alkaline reaction occurs in sugar-free bouillon and in lactose.

As a result of his studies the writer recognizes the fact that there are strains of *B. apisepticus* which vary in cultural characteristics.

Experimental Inoculations

In addition to the puncture method, three other methods of inoculation have been used. By the first, a suspension of the organism was prepared by adding to it a 5 per cent to 20 per cent sugar solution, diluted honey, or water. Bees in cages (Pl 13, Fig. 7) and in colonies were fed with these preparations. From 3 per cent to 10 per cent of the bees in cages generally became infected when inoculated by feeding. Occasionally no inoculated bees, and at other times nearly 20 per cent of inoculated bees, died of infection. A noticeable infection did not occur in colonies inoculated by this method.

In a second series of experiments the organism was prepared in a dry state before inoculating the bees with it. The finely ground remains of bees dead of disease, together with filter paper saturated in a heavy suspension of the organism, were dried at room temperature. To make an inoculation the dried remains of bees or one of the prepared filter papers was placed on the bottom of the cage. Only negative results with caged bees and colonies were obtained with the organism in a dry condition.

In a third method which was used most, inoculations were made by caging bees upon the macerated remains of dead bees wet with water, or by spraying or submerging bees in water suspensions of the organism taken from dead bees, from cultures, or from soil collected near colonies that showed infection. The highest death rate was obtained when inoculations were made with the organism in water. In two experiments, approximately 20 per cent and 30 per cent of the bees caged upon the macerated and wet remains of bees dead of septicemia were killed by this disease. Bees that were dampened by submerging them in a water suspension of the organism and kept in cages became infected in varied numbers. When heavy water suspensions of *B. apisepticus* taken from cultures or from bees dead of disease were used, 60 per cent to 100 per cent of the inoculated bees died. When water with which infected soil had been washed was used, 6 per cent of the inoculated bees in two experiments, 10 per cent of those in 1, and none in another, died of septicemia.

The results obtained with package bees and with colonies are comparable to those obtained with cages of from 50 to 100 bees. One 2-pound package of bees and two colonies were inoculated by the wetting method. Nearly 75 per cent of the bees of the package died of disease within 3 days, while from 60 per cent to 70 per cent of the bees of each of the colonies died following a single inoculation. Nearly 70 per cent of the remaining bees of these colonies were killed by second inoculations made four days later.

SYMPTOMS AND POST-MORTEM CHANGES

NATURAL CONDITIONS. The infected bees become restless and refuse food. Progressive weakening occurs and the ability to fly is soon lost. When exposed to higher temperature, 30° to 37° C, sufficient strength may be recovered, during early stages, to enable them to take wing again, but this apparent recovery is of short duration and death occurs sooner than at temperatures near 25° C. As weakness increases, the general appearance of the diseased bees is quite similar to that of chilled bees.

When bees are unable to fly their movements become slow and uncertain, and they frequently fall on their sides or backs. In the last stages of disease the only signs of life are feeble movements of the abdomen, legs, or mouth parts.

In many cases the blood of the sick bees and those that have recently died is found to have lost its pale brown color and assumed a milky hue, due to the presence of innumerable organisms. Bacteria are present in the blood of all the body divisions but preparations for examination are most easily made from the thorax. After death, changes occur with considerable rapidity under favorable conditions of temperature and moisture. The abdomen loses much of its bright color and becomes dark brown to blackish, especially on the under side. The body wall remains intact for a time but soon loses its firmness. Even with the most careful handling, the appendages fall off and the head, thorax, and abdomen come apart at their articulations (Pl. 12, Fig. 1). After death the hairs on the body are easily rubbed off. The softer tissues undergo a rapid change. The thoracic muscles lose the healthy, reddish brown color and become dull grayish white. The color than changes to a light brown, deepens rapidly, and finally becomes almost black. Tissues of the abdomen and head undergo similar changes. Under low temperatures and dry atmospheric conditions the changes occur more slowly and are less pronounced.

EXPERIMENTAL CONDITIONS. Following experimental inoculations the symptoms before death and the changes after death are comparable with those already described under natural conditions. A few bees become restless and continue to crawl, about 16 hours after inoculation. These gradually become weaker and die within a few hours. Meanwhile other bees show symptoms. The highest death rate usually occurs in from 20 to 36 hours after inoculation. The organism could be readily cultured from the contents of the rectum 3 days after inoculations were made. No noticeable changes occurred in the gross appearance of the parts of the alimentary canal of the infected bees until after death.

PATHOGENESIS

Adult worker bees of all ages, and queens and drones, are susceptible to infection by wetting with water suspensions of *Bacillus apisepticus*. Drones are attacked as readily as are workers, but the queens in two inoculated colonies were among the last of the bees to die of infection. Italians, Blacks, Carniolans and Italian-black hybrids appear to be equally susceptible. None of the bees of these races are immune. The period from the inoculation of bees to the first appearance of disease is shorter near the optimum temperature for the growth of the organism. No evidence of a change in virulence in culture has been observed. Bees inoculated with the tenth generation of *B. apisepticus*, in culture and with cultures four weeks old, were killed as soon and in as large numbers as when inoculated with the organism from the blood of infected bees.

Immense numbers of bacteria in the food contents appear to cause no intestinal disturbance. The very small percentage of infection that results from feeding bees with heavy suspensions of *Bacillus apisepticus* in water and in concentrations of sugar and honey of from 5 per cent to 50 per cent, may indicate that entry is not made by way of the alimentary canal. If entrance to the blood is gained in this way it would seem that there are predisposing causes, in addition to the presence of the organism, which have not been determined. On the other hand, the high percentage of infection which results when bees are inoculated by wetting, even though they have just gorged themselves with concentrated honey, points to entrance through other of the body openings. After the bees had fed upon water, dilute honey, or sugar syrup, with which large quantities of *B. apisepticus* had been mixed, wetting them with sterile water and with unsterilized tap water, after the manner in which they were inoculated by wetting, caused only a doubtful increase in the percentage of infection.

In experiments with cutworm septicemia and hornworm septicemia, White (3, 4) obtained results similar to some of those obtained with bees in these experiments. A mortality of 100 per cent resulted when the organism was transferred directly to the blood of healthy worms from cultures or from diseased worms. When inoculations of hornworms were made by feeding the organism the mortality was usually less than 20 per cent. Cutworms were not infected by feeding. When 37 silkworms were inoculated by feeding them with leaves wet with an aqueous suspension of a culture of *Bacillus noctuarum* White, 24 of them died.

DISTRIBUTION OF THE DISEASE

Some knowledge of the distribution of septicemia has been obtained since the disease was first observed. Samples of bees of which from 10 per cent to 100 per cent were infected have been received from the following states: New Hampshire, 2 samples; Massachusetts, 2; Idaho, 1; North Carolina, 3; California, 3; Alabama, 1; and Georgia, 1. It is observed that widely separated sections of the country and several of the chief beekeeping sections are represented by these states. It is probably safe to assume that the disease is present in all of the beekeeping sections of the United States.

SPREAD OF THE DISEASE

In the writer's experiments the disease did not, as a rule, spread directly from sick or dead bees to healthy ones. Caged bees that escaped infection for 3 or 4 days after being inoculated did not become infected later, even when the bottom of the cage was covered with dead bees. Uninoculated bees caged on bees dead of septicemia were not infected. In inoculated colonies the death rate returned to normal within 3 or 4 days. The colony in which the disease was first observed under natural conditions is located on shaded ground at the lowest part of the experimental apiary. More infected bees were found about the hives located on low, shaded ground than about those in dry situations exposed to direct sunlight. A California apiary from which three samples of infected bees have been received is located on the floodland of the Sacramento River. As a result of these experiments and observations it would seem that in nature the presence of the organism in a wet condition is favorable to infection.

IMPORTANCE

At present very little can be said concerning the importance of the disease. Such knowledge can be gained from further experimental studies and from extenisve observation in the field, supplemented by microscopical examination of many samples during a period of years. Since the examination of the blood of adult bees has been added to the routine of laboratory diagnosis the number of bees infected with *B. apisepticus* has greatly outnumbered those infected with *Nosema apis*. The colony in the apiary of the Bee Culture Laboratory in which the disease was first observed appeared to be weakened from the daily loss of infected bees for about three weeks. None of the other colonies in the apiary were as seriously affected as this one, although in several of them were found a few bees sick or dead of the disease.

Letters from bee inspectors concerning samples containing this disease indicate that one or a few colonies in an apiary were affected, while others appeared to be free of disease. The following quotations were taken from these letters: 1. "Only 1 hive in my apiary is affected and it seems to be affected very badly, as the ground in front of the hive is covered with bees. The bottom of the hive is full and quite a few bees, which are very dopey are scattered all over the frames." 2. "I am sending you a few bees taken from among those dead or dying in front of a stand which is dying off fast. It does not look like paralysis to us here and does not act like spray or other poison of that character. The colony is the only one in the apiary of some 70 stands so far affected. Bees from this colony die slowly. They will be down and slowly crawling around in front of the hive for hours before they finally die." 3. "An abnormally large number of dead and dying bees have been thrown out at the entrance for several months past. At one time they were even heaped up inside. The colony has honey and healthy brood."

The samples from the above described cases were found to be heavily infected with *B. apisepticus*, the proportions infected being 60 per cent of the bees in No. 1, 70 per cent of those of No. 2, and 90 per cent of those of No. 3. Other samples unaccompanied by letters have been received that were even more heavily infected than these. Samples have also been received that yielded from 5 per cent to 50 per cent of infected bees.

It seems desirable to emphasize the fact that this is not a new disease of bees, but is a disease which has not heretofore been definitely recognized. Additional losses are therefore not to be feared. Now that its presence is known, there is reason to hope that the losses from it may be reduced.

TREATMENT

No attempt has been made to determine methods of treatment. From the facts at hand it seems probable that dryness, such as characterizes sandy and well-drained apiary sites, exposed to direct sunlight, is not conducive to the spread of this disease.

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We will now ask Mr. W. A. Ruffin to give us a paper.

CROP FAILURE

By WINFORD A. RUFFIN, *Extension Entomologist, Auburn, Alabama*

After studying over the subject suggested for this paper it occurred to me that the title "Probable Causes of Crop Failure" would have given much more room for discussion and would certainly have allowed the speaker a greater freedom of expression without the fear of later being embarassed by same. Mr. Bentley, undoubtedly, had in mind in suggesting this subject the southeastern group of states but since more detailed information was at hand on the conditions in Alabama it seemed wise to use the data obtainable on the conditions there as a basis for discussion, but since like conditions produce like results the cause for failure in other states can be determined by a similar procedure as outlined herein.

To me it seems that crop failure might be the results of one or more, possibly all, of the following conditions, namely: Poor colonies or poor management (to me they are one and the same), unfavorable weather for bees to work in the fields, or unfavorable weather for nectar secretion.

Taking these items up in the order given, we have first poor colonies or poor management. From all reports received from over the state and by personal inspection of colonies, I found that bees were in unusually good condition thru March. Two and three frames of brood were found in the colonies in Auburn the latter part of January this year. Colonies in what I have chosen to call the mountain region, which covers all the northern half of the state, were in ideal condition to get a maximum crop of honey from poplar, locust, persimmon and other early blooming flowers. In the clover region and the coastal plains, both of which are in the southern half of the state, bees reached their maximum strength with a slight tendency towards swarming by the first of May, the time for the beginning of the main nectar flows. With the above facts in mind it seems evident that poor colonies had nothing to do with this years crop failure (in Alabama).

The second item, namely, unfavorable weather conditions for bees to gather nectar, may be discussed under two topics. Too much rain would keep the bees in the hive and of course temperatures below normal would prevent the usual flights of the worker bees. By looking over the weather charts for the different regions it will be seen that in the mountain region with the exception of the months of March, June, July and October, the rainfall is below normal and in the months mentioned it is only slightly above normal. In the clover region the rainfall was below normal except during the month of February and it was less than a half inch above normal during that month. In the coastal plains region the rainfall was slightly above normal during the months of February, March, June, August, September and October. It is quite probable, however, that there was not enough rain to interfere with the field work of the bees. By looking now at the temperature column it will be seen that the temperature was above normal during all the months in which a major honey flow should occur except in the mountain region where temperatures below normal occurred in March, June and August. So with the possible exception of this region there was no cause for the field activities of the bees not being normal. It would seem that the probability of weather conditions preventing normal activities of the bees in the field cannot be blamed for the crop failure.

The third and last item pertaining to the possible cause of crop failure is unfavorable conditions for nectar secretion. Since the two items already discussed have been cleared of having had any part in the crop failure of 1927 the cause must fall under the heading just mentioned. It might be well before going further to state some of the factors that affect the nectar secretions of plants as discovered by long experience and somewhat limited research.[1] Some of these factors are, soil moisture, temperature, humidity, atmospheric pressure and sunshine. Insofar as possible I would like to compare for you the condition of the year 1926, which was a good crop year in Alabama, with this year, 1927, which is without a doubt one of the poorest on record. Soil moisture which of course is dependent on the rainfall previous to and during the nectar flow is one of the most important factors of nectar secretion. Kenoyer states that, "a good year has a rainfall slightly above the average." In this connection it is interesting to note that the total rainfall of the first ten months of the year 1926 was 56.04 inches as compared with 36.61 inches during the same period of 1927, a difference of 22.43 inches. It has been found that temperatures slightly above normal occur during good honey crop years. It happens however, that during 1926 the mean temperature for the months in which a major nectar flow might occur is below normal and in 1927 the temperature was above normal except for the month of June. Evidently no correlation can be made of these two years as regard to temperature. The humidity was evidently higher in 1926 than during 1927, this being closely related to rainfall and soil moisture. This was also a factor for the year 1926. "A low barometer is favorable for a good yield." The barometric readings for 1926 during the months March to July were lower than the readings for the same months in 1927.

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[1] (1) L. A. Kenoyer, Iowa Research Bulletin 37. (2) L. A. Kenoyer, Iowa Bulletin 169.

Sunshine also has quite a lot to do with nectar secretion. This is easily understood when light is known to be essential in the production of sugar and other plant foods by the plant cells. During the months March thru July in the year 1926 there were 83 days that were cloudy or partly cloudy. During the same months of 1927 there were 95 days of cloudy or partly cloudy weather, a difference of 12 clear days. Just what effect this difference had in the nectar secretion of the two years can not be determined but evidently these 12 days of sunshine had something to do with the increase of the crop of 1926 over that of 1927.

Quite a few beekeepers say that there is a definite alternation of good and poor years. In this case the statement holds true. I have no records for Alabama from which a comparison of other years can be made.

In conclusion it seems that the crop failure in Alabama this year was caused, with the possible exception of the extreme northern part of the mountain region, where sub-normal temperatures and too frequent showers occurred and prevented the normal flight of the field bees, by low rainfall and consequent lack of soil moisture.

MOUNTAIN REGION

SOURCES OF NECTAR

Common Name	Scientific Name	Date of Bloom
Black Locust	*Robinia pseudacacia*	May
Poplar	*Liriodendron tulipifera*	May
Persimmon	*Diospyros virginiana*	May
Sourwood	*Oxydendrum arforeum*	July
Linden	*Tilia (americana?)*	July

WEATHER CHART 1

Month	Temperature		Rainfall	
	Mean	Depart.	Mean	Depart.
January	40.4	— 1.8	2.78	—2.61
February	53.1	±10.3	4.03	—1.20
March	50.0	— 2.6	6.35	±0.47
April	64.0	± 3.9	4.59	—0.37
May	69.0	± 1.1	3.36	—0.82
June	24.6	— 0.5	4.56	±0.28
July	78.2	± 0.4	6.48	±1.36
August	75.0	— 2.2	3.78	—0.20
September	74.6	± 2.4	0.30	—3.05
October	63.3	± 2.3	3.71	±1.23

CLOVER REGION

SOURCES OF NECTAR

Common Name	Scientific Name	Date of Bloom
Poplar	*Liriodendron tulipifera*	May and June
White Clover	*Trifolium repens*	April to June
White Melilotus	*Melilotus alba*	May and June

WEATHER CHART 2

Month	Temperature		Rainfall	
	Mean	Depart.	Mean	Depart.
January	51.4	±3.2	0.49	—4.62
February	60.6	±9.0	5.99	±0.47
March	59.0	±1.2	3.28	—3.10
April	69.3	±4.0	1.26	—2.99
May	74.4	±1.0	2.95	—0.87
June	79.8	±0.2	3.49	—0.74
July	82.0	±0.1	2.99	—1.69
August	80.0	—0.8	1.46	—2.78
September	79.1	±2.8	1.44	—1.44
October	69.4	±2.8	1.32	—1.12

COASTAL PLAINS OR GALL BERRY REGION

SOURCES OF NECTAR

Common Name	Scientific Name	Date of Bloom
Tupelo	*Nyssa ogeche*	March and April
Titi	*Cliftonia monophylla*	March and April
Poplar	*Liriodendron tulipifera*	April and May
Gall Berry	*Ilex glabra*	May
Black Titi	*Cyrilla racemiflora*	June
Mexican Clover	*Richardia scafra*	June to Frost

WEATHER CHART 3

Month	Temperature		Rainfall	
	Mean	Depart.	Mean	Depart.
January	53.8	± 3.2	0.99	—3.51
February	64.0	±11.6	9.20	±2.87
March	61.8	± 0.7	5.01	±0.13
April	71.3	± 5.7	0.89	—3.08
May	76.4	± 3.4	2.25	—1.57
June	80.7	± 1.2	7.31	±2.42
July	81.2	— 0.1	4.45	—1.76
August	78.6	— 1.9	7.02	±0.35
September	78.4	± 1.7	4.37	±0.46
October	69.5	± 3.5	3.16	±0.86

STATE WEATHER CHART 4

1926

Month	Temperature		Rainfall		Days Cloudy, Ptly. Cloudy	Prev. Winds	Mean Atmospheric Pressure
	Mean	Depart.	Mean	Depart.			
January	45.3	—0.6	8.23	±3.17	22	N	30.13
February	51.3	±3.0	4.42	—0.88	14	NW	30.05
March	50.0	—6.1	6.52	±0.77	18	NW	30.10
April	61.2	—2.3	2.32	—1.97	14	NW	30.06
May	70.4	—0.9	2.99	—0.98	14	SW	29.99
June	77.6	—0.7	4.93	±0.67	18	S	29.98
July	79.2	—0.9	6.13	±0.68	19	SW	29.99
August	80.6	±1.0	6.90	±2.36	21	S	30.03
September	79.4	±4.0	5.50	±2.23	16	SE	30.03
October	66.9	±2.5	2.10	—0.52	14	S	30.02

1927

Month	Temperature		Rainfall		Days Cloudy, Ptly. Cloudy	Prev. Winds	Mean Atmospheric Pressure
	Mean	Depart.	Mean	Depart.			
January	49.2	± 3.3	1.14	—3.92	16	N	30.26
February	58.7	±10.4	6.45	±1.15	20	S	30.08
March	57.0	± 0.9	4.89	—0.86	18	S	30.13
April	68.1	± 4.6	2.28	—2.01	16	SW	30.06
May	73.1	± 1.8	2.55	—1.52	17	SW	30.01
June	78.2	— 0.1	5.28	±1.22	23	SW	30.02
July	80.8	± 0.7	4.04	—1.41	21	SW	30.05
August	78.5	— 1.1	3.56	—0.98	18	W	30.01
September	77.8	± 2.4	1.43	—1.84	13	S	30.02
October	67.8	± 3.4	2.01	—0.61	9	N	30.05

CHAIRMAN MILLEN: The next paper is by W. J. Nolan.

SEASONAL BROOD-REARING ACTIVITY OF THE CYPRIAN HONEYBEE

By W. J. NOLAN, *Bee Culture Laboratory, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

The seasonal brood-rearing activity of a colony of Cyprian honeybees proved on investigation to be strikingly similar to that typical of colonies of Italian honeybees in the same apiary. Furthermore, this colony exhibited no tendency to tolerate laying worker-bees while it had a laying queenbee, nor did it build more queencells than did Italian colonies in the same apiary at the same time. Its queenbee gave no evidence that her race was any more prolific than the Italian race of honeybee.

Statements have often appeared in beekeeping literature which imply that races of honeybees differ from each other in respect to the normal course of their brood-rearing activity throughout the year. So far as is known no statement to this effect, as yet made, has been founded on results from scientific investigations of the normal seasonal brood-rearing activity of any races in question. No particular reason has been advanced as to why one race should differ from any other in its response to a given set of brood-rearing stimuli.

During the last few years the writer has been engaged in an intensive study of the brood-rearing activities of colonies, all of which, it happens, were headed by queenbees of Italian blood. As a result of these investigations the writer (*4, p. 120; 7, p. 36*)[1] has on previous occasions endeavored to point out that under normal conditions brood-rearing activity tends to follow the same general seasonal course or cycle in any given locality year after year. Certain characteristic seasonal fluctuations exist, of course, in the brood-rearing cycle of any particular region. These are fairly constant both in time and relative magnitude.

The seasonal regularity of fluctuations in the brood-rearing cycle is highly correlated with the recurrence in any given locality, at approximately the same time annually, of various nectar flows and pollen yields. This correlation is usually shown by increased brood-rearing activity during at least the early stages of a nectar flow or pollen yield. An intense nectar flow or pollen yield, however, may serve to check brood-rearing activity if conditions are such as to cause sufficient incoming nectar or pollen to be deposited within the brood area proper to restrict the cells available to the queen for egg-laying purposes. A period lacking incoming nectar or pollen is normally one of lessened brood-rearing activity. So close is the relationship between brood-rearing activity and incoming nectar or pollen, or the absence of either, that the normal seasonal course of brood-rearing in any region, at least for the Italian bee, can be predicted by a knowledge of the various local nectar flows and pollen yields, their intensity, and their duration.

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[1] Reference is made by number (italic) to "Literature cited," at end of article.

This close relationship between nectar flows, pollen yields, and brood-rearing has been observed by the writer not only in colonies headed by queens reared from strains of Italian bees which have been kept for a number of years in the apiary of the Bee Culture Laboratory at Somerset, Md., where his investigations have been carried on, but it has also been observed in the same apiary in colonies headed by Italian queenbees reared in other sections of the United States from strains accustomed to nectar flows and pollen yields quite different from those prevailing at Somerset. The same relationship has likewise been found even in colonies headed by queenbees imported from Italy. Since in relation to the presence or absence of incoming nectar or pollen the seasonal brood-rearing cycles of colonies headed by Italian queenbees from widely separated regions all followed the same general course, and inasmuch as no physiological or anatomical ground has yet been shown in bees of various other races which would cause a brood-rearing response to the same stimuli other than has been observed in the Italian bee, the writer was led to query whether, on making due allowance for any racial tendency as to prolificness, colonies headed by queenbees of the other races do not after all show the same seasonal response to seasonal nectar flows and pollen yields as do Italian bees.

In order to obtain an empirical answer to the foregoing question, a study of the seasonal brood-rearing activity of various "races" was begun at the Bee Culture Laboratory in 1926. In the latter part of the active season of 1925 several queen bees of different "races" had been imported alive. Among them was a queen bee of the Cyprian race; and the performance of her colony in 1926 is the basis of this paper. For purposes of identification a distinctive mark was painted on the thorax of this queen bee and her larger right wing was clipped.

The term "race" as used in this paper corresponds to the term "variety" used by von Buttel-Reepen (*1, p. 168*) in his classification of the honeybee. Thus he classifies each of the European races, and the Cyprian also, as a variety of the "subspecies" *mellifica* of the species *Apis mellifica*. According to his system the name of the Italian race is "*Apis mellifica mellifica* var. *ligustica*, Spinola 1808," while that of the Cyprian race is "*Apis mellifica mellifica* var. *cypria*, Pollmann 1879." C. P. Dadant (*2, p. 328*) and Rotter (*8, p. 4*), on the other hand, have held that the Cyprian bee is more closely allied to the Egyptian than v.Buttel-Reepen's system would lead one to suppose. The latter has held that the Egyptian is a variety of *Apis mellifica unicolor*, which, according to his classification, is a subspecies differing from the one including the Italian and Cyprian. Regardless of the merits of either view, the casual observer would probably be apt to consider the Cyprian more closely allied to the Italian than is the Carniolan or any of the other European races of the honeybee.

The term "effective egg-laying rate" is used in this paper in the sense in which the writer (*6, p. 443*) has employed it on previous occasions. It relates only to those eggs from which worker bees actually develop.

The Cyprian queenbee in question was received from Cyprus in August, 1925, and was immediately placed in a nucleus which contained only newly emerged or emerging brood. A few frames of sealed brood were added later. The colony at the beginning of winter had not built up to the strength desirable for entering winter or for insuring the queen an optimum population for maximum brood-rearing efforts in the following spring.

The photographic method previously described by the writer (*7, p. 4*) was used for making brood measurements to determine the course of the brood-rearing cycle. Photographic records of all sealed brood in the Cyprian colony were taken at least every twelve days during the active season with the exception of a fourteen-day interval at the beginning of March, a thirteen-day period in August and an eighteen-day period beginning with the 18th of September. Twelve days is the average time during which worker brood remains sealed.

SEASONAL BROOD-REARING CYCLE OF THE CYPRIAN COLONY

In 1926 the Cyprian colony (Table 1) was first examined on March 1. It had about 2 pounds of bees and 41 cells of sealed brood. Some Italian colonies in the same apiary had even more sealed brood at this time. Brood-rearing in Washington often begins in the latter part of February, pollen from willows usually being then available. Although the quantity of brood in the Cyprian colony increased slightly until the middle of March, inclement weather in the forepart of the month, which cut down flights, for pollen at least, led to a decrease in the quantity of sealed brood a little later. The same was true of all the Italian colonies investigated.

After the inclement weather in March sufficient pollen and nectar were available to cause a continuous increase in the quantity of sealed brood until the maximum was reached at just about the time of the main honey-flow. This increase was much more rapid after the latter part of April. Prior to this time the colony did not have sufficient strength to build up as quickly as did some other colonies. For instance, an Italian colony which survived winter with twice as many bees was given an additional 3-pound package of bees on March 25. On this date it had 4,422 sealed cells of worker brood, whereas the Cyprian colony had only 1,553. On April 24, the date when the Cyprian colony began its greatest rate of spring expansion, the reinforced Italian colony had 14,829 sealed cells of worker brood, whereas the Cyprian had only 6,249, or less than one-half as many. At the date of the season's maximum, however, this lead had been greatly reduced, the Italian colony having 18,780 sealed cells of worker brood, in contrast with 15,737 in the Cyprian colony.

The nectar available in April was more than sufficient for brood-rearing purposes, daily gains of 5 and 6 pounds being made by some colonies. The nectar flow in May was especially good, as much as 19 pounds gain in one day having been obtained by a scale colony during the main flow, that from the tulip-tree (*Liriodendron tulipifera*), which began about May 14 and continued about 10 days. A nectar-flow from black locust (*Robinia pseudo-acacia*) came before the nectar flow from the tulip-tree and even overlapped its beginning. June also was marked by much nectar from various sources, more particularly from white sweet clover (*Melilotus alba*), basswood, and, somewhat exceptionally, white clover (*Trifolium repens*). The clovers continued secreting nectar until the end of June.

The maximum amount of sealed brood population for the entire season was found on May 18. This means that in laying the eggs from which this amount of brood developed the queen attained her season's maximum daily egg-laying rate, as far as sealed brood is concerned. Since the two succeeding counts show an abrupt drop in the amount of sealed brood, the queen's effective daily egg-laying rate must have suffered some sudden check when the eggs represented by this brood were laid. As mentioned already, a good honey flow actually had been in progress for several days previous to May 18, so that in view of the fact that the lower hive-body had been well filled with honey from the preceding year, the brood area in the second hive-body was restricted by the presence of incoming nectar. This caused the reduction in the activities of the queen. A somewhat similar occurrence happened in a more striking manner in 1921 in an Italian colony described by the writer elsewhere (*4, p. 123; 7, p. 15*). As in the colony of 1921, this condition in the Cyprian colony became relieved a little by the end of May. Under the influence of increased room, the presence of sufficient nurse bees, and some incoming nectar, the brood-rearing rate mounted again until checked slightly once more by incoming nectar from sweet clover. This is even more noticeable in the case of sealed worker brood alone (Table 1) than in the case of total sealed worker and drone brood. The maximum effective worker egg-laying rate for any 12-day interval during this particular period was reached late in June. This is shown by the fact that the resulting maximum in sealed worker brood was found on July 8.

From the end of June until the beginning of a pronounced pollen yield in August the course of brood-rearing activity was downward. During this interval there was a comparative dearth of incoming nectar and pollen. The brood-rearing response to the pollen yield in August was quite marked. Following this came another decline in brood-rearing. Soon afterwards, pollen, and more especially the fall nectar flow from various species of Compositae, proved to be stimuli for a period of increased brood-rearing activity during the latter part of September. Inclement weather thereupon led to an entire cessation of brood-rearing activities in the fore part of October.

At no time in the year did the colony have the use of less than 2 hive-bodies. During the main honey flow it was necessary to give additional room for incoming nectar.

It is interesting to trace the course of drone rearing in the Cyprian colony (Table 1) during the season. Except in the honey-flow period of May and June, and once in the first week of September, on no occasion were more than 100 sealed drone cells found. It is worthy of note that the one exception in September, when 200 drone cells were found, is to be connected with the increased pollen yield in August. The height of drone brood-rearing activity was not simultaneous with the maximum worker brood-rearing activity, but came at the time when the brood area proper was crowded by incoming nectar during the main honey flow. At this time the queen took advantage of whatever cells were available, and was found to lay even in drone cells at the bottom edges of combs in the lower hive-body, which were separated by full combs of honey from combs containing brood of any description. The increased brood-rearing activity in June, already mentioned, was caused by an increase in the laying of worker eggs accompanied by a decrease in the laying of drone eggs.

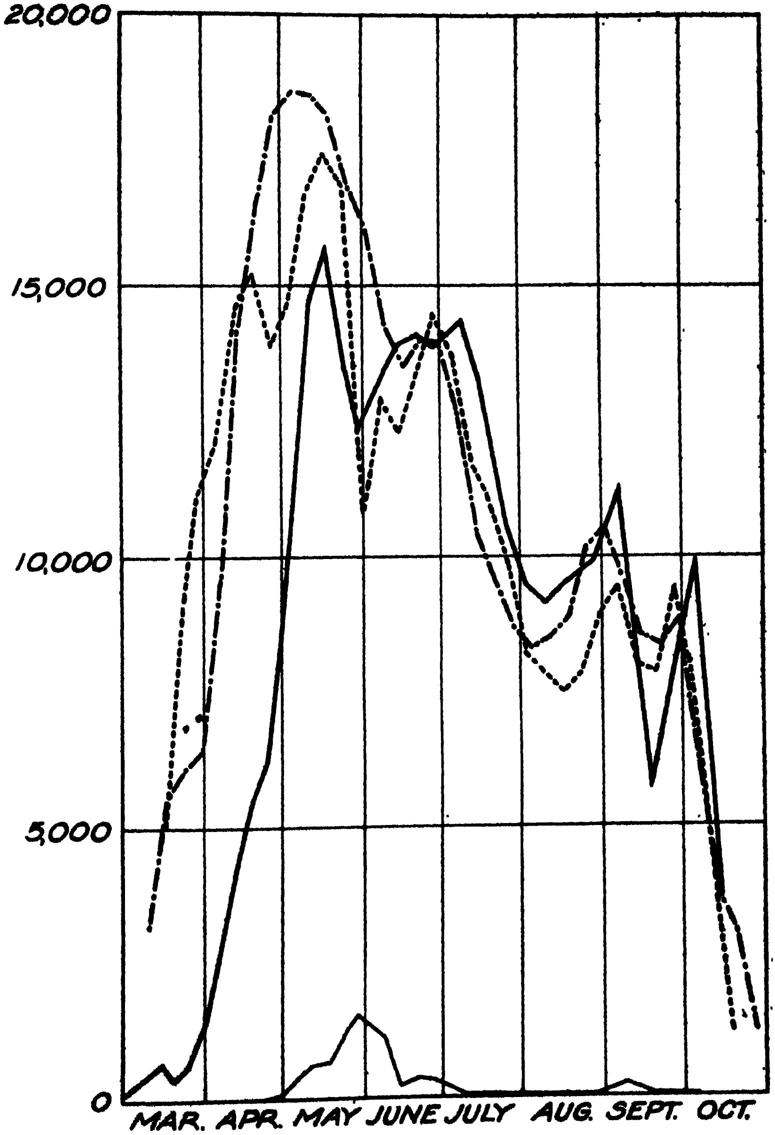

FIG. 23. Curves showing number of cells of sealed worker brood observed at intervals in an Italian colony during the active season of 1921 (dotted line) and 1922 (broken line), and in a Cyprian colony during active season of 1926 (solid heavy line). The number of drone cells in the Cyprian colony during the active season of 1926 is represented by solid narrow line.

THE CYPRIAN COLONY'S BROOD-REARING CYCLE COMPARED WITH THAT OF AN ITALIAN COLONY. Having traced the brood-rearing cycle of this Cyprian colony throughout 1926, it will be well to compare it with that of typical Italian colonies. In 1926 the writer studied the brood-rearing cycle of no Italian colony which was under undisturbed conditions throughout the season. Colonies undisturbed at the beginning of the season, however, as well as others undisturbed towards its end, showed the same general course of brood-rearing activity as was displayed by the Cyprian. Since, furthermore, as stated earlier, there appears to be a definite course of seasonal brood-rearing activity which shows the same general trend year after year, under normal conditions individual yearly differences being due to variations in time and intensity of the various honey flows and pollen yields, a comparison with the brood-rearing cycle of an Italian colony in 1921 and 1922, described in detail elsewhere (*4; 7, pp. 14–16*), will be used for the purpose of this paper. The seasonal brood-rearing cycle of other Italian colonies studied by the writer in the same apiary prior to 1926 might have been chosen, which would have served this purpose just as well.

In the figure accompanying this paper only sealed worker brood is represented by the curves for the three seasonal brood-rearing cycles compared. The curves previously published for the Italian colony (*4, p. 121; 7, p. 48*) represented the total sealed brood, both worker and drone. Whether sealed drone cells are included or not makes scarcely any difference in the case of the Italian colony because in neither 1921 nor 1922 were as many as 600 sealed cells of drone brood found in the Italian colony on any one count (*7, p. 5*). In both years, the season's maximum occurred during the major honey-flow period, and scarcely a sealed drone cell was found after June. In the Cyprian colony, likewise, as noted previously, the larger share of the sealed drone brood was found during the major honey-flow period, while a negligible number of sealed drone cells were found in this colony after June with the exception of the one occasion in September.

Before comparing further the performance of the Cyprian colony with that of the Italian colony in 1921 and 1922 it will be well to describe briefly the general seasonal brood-rearing cycle in the apiary of the Bee Culture Laboratory at Somerset, Maryland, in its relationship to local nectar flows and pollen yields as observed in Italian colonies by the writer during the past seven years. Under normal conditions brood-rearing activity begins with the first pollen in the latter part of February, usually from willows, and continues to increase its rate, often quite astonishingly, with the succession of pollen yields and nectar flows in March and April, until the season's maximum is reached during or just before the main honey-flow in the middle of May. The brood-rearing rate then drops somewhat, due to the crowding of the brood-nest by the rapidly incoming nectar. A high rate of consumption at this time of the year, somewhat freeing the brood-nest, coupled with the stimuli of incoming pollen and nectar in lessened but appreciable quantities in June halts the downward trend temporarily until July, when a dearth of both incoming nectar and pollen occurs. A decline in brood-rearing ensues which is checked by an abundant pollen yield in August. This causes another rise which continues until about the beginning of September, when another drop in brood-rearing activity takes place. Additional pollen, but more especially the fall nectar flow, soon brings again a brief upward movement, lasting until the beginning of October. The supply of pollen and nectar in the field diminishes quickly in October due to the weather. At the same time brood-rearing activity falls off rapidly until finally there is a complete seasonal cessation.

Considering the fact that the Cyprian colony was below normal strength at the beginning of 1926, a condition which would retard the rate of *initial expansion*, (*7, p. 7*), a remarkable similarity exists in the curves (Fig. 23) showing the Cyprian's brood-rearing performance and that of the Italian colony in 1921 and 1922. The Cyprian reached its season's maximum of sealed worker brood at practically the same time as the Italian colony in 1921, and only two weeks later than the Italian colony in 1922. Because it was weaker in early spring, it reared much less brood in March and April than did the Italian colony in either 1921 or 1922. This led to a lower season's maximum in May. As a result, the Cyprian colony did not have as many field bees to gather surplus honey during the main honey-flow as did the Italian colony in the two years named. Nevertheless, it gathered sufficient surplus to provide more than enough pollen and nectar at all times during the rest of the year to keep up normal seasonal brood-rearing activity, as well as to have sufficient stores for winter. Furthermore, it drew out sufficient foundation for ten new brood combs.

It will be noted that in all three instances there was a steady decline in brood-rearing during July. This decline was checked by the pollen yield in August. As a matter of fact, from the latter part of June throughout the rest of the year the seasonal performances remain quite close to each other, considering seasonal variations in the time of occurrence and intensity of the nectar-flows and pollen yields involved. The September decline was somewhat more pronounced in the case of the Cyprian colony than in the case of the Italian colony, owing in part to adverse rainy weather conditions during the forepart of the month which limited incoming supplies for a few days. All other colonies under investigation at this time in 1926, however, showed as pronounced a drop at this time. Due to this same decline, on the advent of more favorable weather the response on the part of the Cpyrian colony to pollen and the September nectar flow seems somewhat more marked than in the case of the Italian colony in 1921 and 1922. The maximum level attained, however, is only slightly in excess of that in 1921. The decline in October is just as sharp as for the Italian colony, and brood-rearing ceased just as early or earlier.

The three seasonal brood-rearing performances just described obviously offer no ground for concluding that the Cyprian colony responded to seasonal brood-rearing stimuli in any other way than has been found characteristic of Italian colonies at Somerset, Maryland. If the Cyprian bee is at all inclined to rear brood out of season this inclination should certainly be manifested in the apiary of the Bee Culture Laboratory during July and early August, the one season which is unmarked by the influence of any pronounced nectar flow or pollen yield in the vicinity of Somerset. Such an inclination should also appear about the middle of September, another period which is little influenced by pollen or incoming nectar. Yet, when we examine the performance of the colony under discussion, we find that its record after early July practically parallels that of the other two examples given. In fact, its whole seasonal performance, if we bear in mind the weakness of the colony at the beginning of the spring, is only a duplication of seasonal brood-rearing performances of various other Italian colonies at the Bee Culture Laboratory as determined by brood-rearing investigations.

TOLERANCE OF LAYING WORKERS AND ABUNDANCE OF QUEENCELLS. Certain writers have stated that the Cyprian race is inclined to tolerate laying workers in the same hive with a laying queen and that it builds more queencells than does the Italian. The presence of laying worker bees was not in evidence in this particular colony at any time during the period of active brood-rearing. On no occasion were any sealed cells of drone brood found in worker cells which might indicate the activity of such workers, nor were cells observed with numerous eggs or with eggs deposited in a haphazard position in the cells as is characteristic of laying workers. The marked, imported Cyprian queenbee survived in this colony throughout the entire season.

As for queencells, scarcely one was found. In fact, more were found in normal Italian colonies in the same apiary during the season than were found in the Cyprian colony.

PROLIFICNESS. It has often been maintained that the Cyprian bee is more prolific than the Italian bee, but the highest daily effective egg-laying rate attained by the Cyprian queenbee discussed here was only 1,312 over any 12-day period, whereas the writer, (*4, p. 123; 5, p. 430; 6, p. 444; 7, p. 35*) has reported higher rates for Italian queenbees. It must be borne in mind, however, that this queenbee was somewhat handicapped by the lack of strength in her colony early in the year. From the end of the main honey-flow until the end of the season, on the other hand, there were sufficient bees in the colony for all brood-rearing purposes. Nevertheless, the effective egg-laying rate of this queenbee, when compared with that of certain Italian queenbees investigated by the writer in the past seven years, was such at no time from the first of July until the end of the year as to warrant the conclusion that she belonged to a race more prolific than the Italian.

It has frequently been stated by beekeepers that shipping a queenbee impairs her laying ability. Evidence that long shipments do not injure queenbees was given by Allen Latham recently (*3, p. 508*). He reported that a queenbee imported from Cyprus "did wonderful work for two seasons and fair work a third season." Whether or not the trans-Atlantic trip affected the egg-laying ability of the Cyprian queenbee described in this paper is only a matter of conjecture. Considering the strength of her colony in the spring, she performed a creditable season's work in egg-laying. From the end of June to the close of the season, her effective egg-laying rate for the period covered by any of the brood counts compares favorably with that found in Italian colonies on the same approximate dates.

SUMMARY

In summarizing some of the results of this investigation it may be stated that the seasonal brood-rearing cycle of the Cyprian colony was strikingly similar to that of Italian colonies studied in the same apiary. In other words, using the normal seasonal brood-rearing activity of Italian colonies in the same apiary as the basis for comparison, there was no tendency on the part of the Cyprian colony to rear brood "out of season."

Furthermore, this colony on no occasion in the period covered by this paper showed a tendency to tolerate laying workers when it had a laying queen in the hive, nor did it build queencells more abundantly than did Italian colonies under observation in the same apiary at the same time.

Lastly, this particular Cyprian queenbee gave no evidence of being more prolific than Italian queenbees in colonies whose brood-rearing activity has been investigated by the writer.

TABLE 1. RECORD OF SEALED BROOD IN CYPRIAN COLONY, IN 1926

Date		Worker Brood	Drone Brood	Total
March	1	41	——	41
	15	660	——	660
	19	368	——	368
	25	608	——	608
April	1	1,553	——	1,553
	7	2,986	——	2,986
	12	4,297	——	4,297
	19	5,593	9	5,602
	24	6,249	23	6,272
	30	8,283	66	8,349
May	7	12,240	431	12,671
	12	14,710	625	15,335
	18	15,737	661	16,398
	24	13,499	1,270	14,769
	29	12,387	1,575	13,962
June	8	13,426	1,180	14,606
	14	13,949	215	14,164
	21	14,127	370	14,497
	28	13,925	343	14,268
July	8	14,375	33	14,408
	16	13,186	24	13,210
	26	10,548	18	10,566
Aug.	2	9,472	17	9,489
	9	9,133	10	9,143
	15	9,430	22	9,452
	28	9,931	16	9,947
Sept.	7	11,246	229	11,475
	18	5,702	17	5,719
Oct.	6	9,869	5	9,874
	15	3,648	——	3,648

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SECRETARY BENTLEY: Before any of you leave, I have one little matter I want to tell you about.

We have with us this afternoon many of the members representing the Tennessee Beekeepers' Association, and I am sure they will want to read carefully some of these papers. Already several have asked me where they can get the papers. All papers will appear in one issue of the JOURNAL OF ECONOMIC ENTOMOLOGISTS. Anyone can secure a copy by addressing C. W. Collins, at Melrose Highlands, Massachusetts. I think single copies are 75 cents.

While I am standing, I want to say that at the close of this session the Tennessee Beekeepers' Association will have a short executive session to elect officers for the following year. At our last annual meeting it was voted that we pool our interests today and tomorrow by attending these meetings with scientists, in lieu of our regular annual meeting.

CHAIRMAN MILLEN: We are open for discussion on the paper by Mr. Nolan. If there is no discussion, the next paper will be by E. J. Anderson.

THE PATHOLOGICAL CHANGES IN HONEYBEES INFESTED WITH THE ISLE OF WIGHT DISEASE

By E. J. Anderson, *Extension Apiarist, The Pennsylvania State College*

Abstract

It was found that the mouth parts of the mite were sufficiently long to extend a relatively long distance through the tracheae and injure the surrounding muscle and nerve tissues. It would appear that paralysis could occur in the bee as a result of injury to these tissues, inflicted by the mite while feeding.

For many centuries heavy losses of bees have been recorded in the literature of Great Britain and other countries (1). In 1902 another period of heavy losses began. As in previous cases, the cause was unknown. Efforts were made by a number of workers to ascertain the cause of such a heavy death rate. Finally in December, 1919, Miss Elsie Harvey, a student of Professor John Rennie of the University of Aberdeen, found a new species of mite in a preparation of permanently preserved thoracic gland. The next year, the mite in all stages was found by P. Bruce White in the thoracic tracheae of crawling bees suffering from the Isle of Wight disease. Professor Rennie described this mite and gave it the name *Tarsonemus woodi*. The mite was later studied by Hirst (2) and placed in the genus *Acarapis*.

P. Bruce White in the series by Rennie and his associates (3) gave two explanations for the heavy death rate,—one, the active injury wrought upon the host by a parasite developing and living at the expense of its body fluids, with possibly a toxic action on the host; two, the passive role of the mite in hindering or inhibiting the normal functions of the infested organs. He found that a number of muscle fibers showed a distinct difference in color and presented a smaller wasted appearance.

The author, in an effort to add to the limited information available regarding injury suffered by the bees, undertook the studies which are discussed in this paper. Considerable assistance was given the author by Dr. E. F. Phillips who was directing the graduate work in beekeeping.

The material used by the author was obtained from Dr. Morganthalor, Switzerland, who had sent it to Dr. E. F. Phillips, Professor of Apiculture, Cornell Univerity. The specimens had been fixed in 15 per cent glacial acetic acid in 95 per cent alcohol and were preserved in alcohol until used.

A number of bees were examined and dissected in order to obtain some idea of the distribution of the mites. In all such material the infested tracheae were easily identified, since the mite was opaque in comparison to the colorless and nearly transparent walls of the tracheae. The mites had also caused a brown staining of the tracheal walls, which helped to make the infested tracheae more easily recognized. The mites were found more commonly in the main trunk leading to the spiracle. They were also found in all the branches large enough to accommodate their size, such as in the tracheae leading to the ventral part of the front of the thorax, the tracheae leading to the head, to the thoracic salivary glands, and to those passing over the indirect flight muscles. This is significant, since a large number of important organs are supplied with air from branches of these infested tracheae.

Sections of diseased tracheae were studied in stained and unstained preparations, but no injury to the tracheae could be seen, even with a high powered microscope. The tracheae were soaked in caustic potash to remove all waste and then prepared on slides and stained, but no mechanical injury to the walls could be seen. It would seem, therefore, that any mechanical injury done to the tracheal walls is of minor importance.

P. Bruce White found the mouth parts extending through the traechal walls in only two cases. It is probable that in the material used by the author the fixing solution had caused the mites to withdraw their mouthparts.

A study was made of fresh normal muscles to ascertain the nature of the tracheal system supplying the muscles with air. Large branches from the main trunks lead directly to the indirect flight muscles where they divided and redivided, and finally branched out into numerous tracheols. These in turn branched out so that they came in contact with all the fibrils. It would seem essential that the large tracheae be kept open to permit a flow of air into this complex system of tracheols. When a tracheal branch is obstructed by a mite, as was found to be the case in several bees, little if any air can pass, Fig. 25. Such a condition would probably prevent oxygen from reaching an area of muscle tissue, making that area nearly functionless, and thereby causing the crawling condition common to bees suffering from the Isle of Wight disease.

The muscle tissues of some infested bees were found to be abnormal near the more heavily infested areas of the tracheae. The tissue was brownish in color, instead of white, and was somewhat brittle. Some of both normal and abnormal tissue was sectioned and stained separately with both Delafields and iron Hematoxylin. The diseased tissue did not stain evenly as did the normal. The discs were not definite in outline, and had a somewhat wasted appearance.

The muscle tissue near the tracheae was probably irritated and injured to a considerable extent by the beaks of the mites while feeding. The discoloration might also have been brought about by a toxic secretion. The beaks of the mites are considerably longer than the tracheal walls are thick, so they could extend some distance into the surrounding tissue, Fig. 26.

When the first attempt was made to section the thorax of a bee, it was found that the chitin did not cut readily but tore the tissues inside. Successful results were obtained by embedding the thorax in wax, and then shaving off the chitin with a sharp razor blade. The material was then re-embedded in paraffin and sectioned.

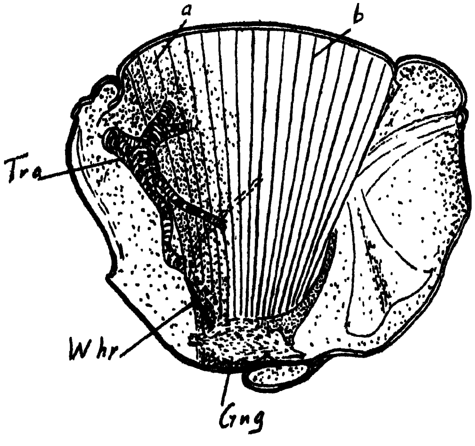

FIG. 24. Cross section of thorax of a bee showing the large nerve, Whr, near the infested tracheaa, Tra.

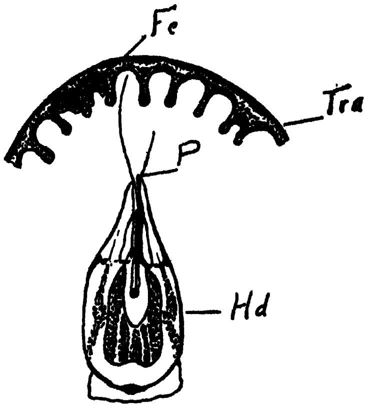

FIG. 26. Head and beak of a mite, Hd. P. near a section of a tracheal wall, Tra.

During the process of dissecting some bees, it was noticed that the large nerve passing to the base of the wing comes in close contact with one of the large tracheae frequently infested with mites, Fig. 24. This nerve passes through that part of the infested bee where the muscle tissues undergo a pathological change. In several infested specimens this nerve appeared watery instead of evenly white as in normal bees. This would indicate a pathological condition which could account for the loss of the power of flight, and might also account for the disjointed wings of many infested bees.

The following conclusion can be drawn regarding the pathological action of *Acarapis woodi* in the thorax of the honeybee.

1. A mechanical obstruction of smaller infested tracheae occurs which probably results in the loss of function of those tissues supplied with oxygen from it.

2. Mechanical injury is inflicted on the tissues adjoining the infested tracheae, including the thoracic salivary glands, the indirect flight muscles and the large nerves passing to the base of the wings. Such injury would cause a diseased condition to the punctured muscle and nervous tissue, and would probably cause paralytic condition of the bees.

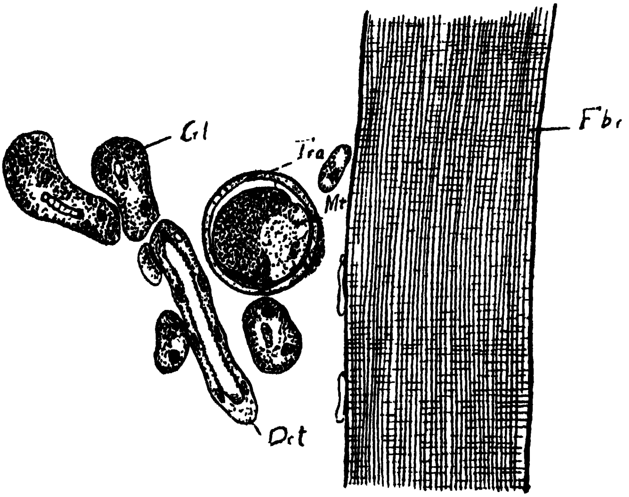

FIG. 25. Cross section of infested tracheae, Tra, nearly closed by a mite, Mt.

3. There is a slight possibility of a toxic secretion passing into the tissues surrounding the infested tracheae.

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CHAIRMAN MILLEN: We are open for discussion on this paper.

DR. EWING: What have they found in Canada with regard to the material sent to Europe?

CHAIRMAN MILLEN: It was supposed to have been found in the Province of Quebec, but we have had no further confirmation on that point.

W. J. NOLAN: Has there been any further study made?

CHAIRMAN MILLEN: We have made a search in Ontario, but we have not found any traces of it yet.

SECRETARY BENTLEY: Mr. Nolan, will you make a brief announcement in regard to Dr. W. W. Alpatov and the work he is doing at Johns Hopkins University.

W. J. NOLAN: Dr. Alpatov is one of the outstanding apicultural research workers at the present time. He is particularly interested in the biometrics of the honeybee. He has found that in his country the tongue lengths of northern bees are shorter than those of southern bees. Of course, we don't think that applies to this country because our northern bees are often from queens which are reared in the South. He worked in Russia where they have little experience with package bees or extensive queen-rearing operations.

CHAIRMAN MILLEN: I will now ask the Nominating Committee to report.

W. J. NOLAN: The Committee selected Professor Wilson of the University of Wisconsin as the Chairman for next year, and the first choice for Secretary was Professor Bentley. He informed us he would be unable to serve again, so we have selected Professor Cory of the University of Maryland.

CHAIRMAN MILLEN: You have heard the recommendations. What is your wish? The report was adopted.

CHAIRMAN MILLEN: There is one other point I think we should bring up at this time, and that is the present Secretary, who is on my right, has occupied this position for quite a number of years, about twelve years, I think. Due to the stress of work and other positions which have been thrust upon him, he has had to relinquish the office this year.

I know from experience that the Secretary does all the work and gets none of the credit, if everything goes well. If things go wrong, then the Secretary is the man who bears all the blame. I should like to see this meeting recognize the work which Professor Bentley has done, by a very hearty vote of thanks.

The audience gave a rising vote of thanks to Professor Bentley.

CHAIRMAN MILLEN: If there is no other business, this meeting will stand adjourned.

The meeting adjourned at 5:15 o'clock.

Tuesday Evening, December 27, 1927

The meeting convened at 7:30 o'clock, Chairman Millen presiding.

The meeting was in the form of a round table. There were 16 present, 10 different states being represented. Two papers were presented.

A paper on "The Packing of Honey" by Mr. Atkins was read by Kenneth Hawkins of Watertown, Wisconsin.

COMB HONEY PACKED CAREFULLY PREVENTS DAMAGE IN SHIPPING

By E. W. ATKINS

Recently we conducted an investigation, with the co-operation of the American Railway Express Company, to ascertain if small lots of comb honey could be shipped with a reasonable degree of safety. The investigation showed that, in addition to the damage comb honey might receive in handling, the vibration caused by rapidly moving trains was often sufficient to break the delicate comb cells. To test this, an official of the express company obtained cases of comb honey in which there were no damaged or leaking cells. He personally carried the honey to the express car and set it on the floor of the car. The effect of train vibration was then studied. At the end of a 50 mile trip it was found that cells in many of the sections were cracked and honey had started to leak out.

The careful grading of comb honey is also an important step in successful shipping of this fragile product. We shall always remember a demonstration given by Frank Rauchfuss, manager of the Colorado Honey Producers' Association, at one of the association's meetings, on the importance of carefully grading comb honey for safe shipping. He took one section of comb honey in which all of the cells next to the wood of the section were filled with honey and sealed over, and one in which none of the cells attached to the wood contained honey. In turn he held these sections flat in his hand and threw them up in the air about 2 feet and allowed them to drop on a table in front of him. The comb honey which contained cells filled with honey next to the wood stood this severe test without breaking out of the section. The other comb of honey entirely broke out of the section. Honey adjacent to the wood seems to have a cushion effect which helps reduce shocks.

PACK ALL SHIPMENTS CAREFULLY. The distance that a shipment of comb honey has to travel is no criterion as to the care it should receive in packing. For instance, a shipment from Stevens Point, Wisconsin, to Milwaukee, will be handled 22 times, whereas a shipment from Milwaukee to New York will be handled only 10 times

In order to ascertain if comb honey could be shipped with any reasonable degree of safety in single case lots, we made up a number of different kinds of crates and shipped comb honey in them to distant parts of the country, at the American Railway Express Company's expense and had them report on the honey's condition at destination A general view of the crate that was most highly recommended by the express company from the result of this test is shown in figure 27 This crate is for 1 single-tier case of comb honey and is 23 inches high, 18½ inches wide and 11½ inches deep, outside dimensions

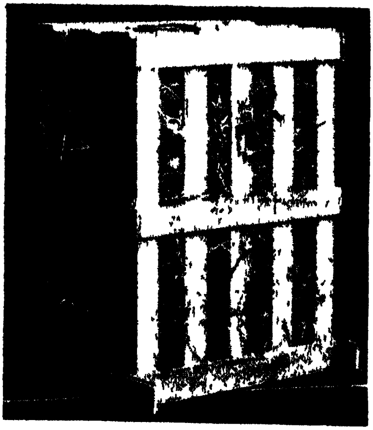

Fig. 27. Type of crate highly recommended by Express Company

Note particularly that the case of honey is carried in the crate on end. The sections stand straight up, with each row one above the other. This is to reduce the effect of train vibration. Two cleats are nailed across the bottom ends of the crate as shown in the figure. These cleats should extend at least 3 inches beyond each side of the crate, to prevent it from tipping over. This method is similar to the one successfully used for shipping plate glass.

The bottom of the crate should be cushioned with 4 inches of straw, packed tightly, to reduce shocks and train vibration Straw is also packed tightly on all sides.

It is not necessary to put straw over the top of the case. However, it is important to plainly mark the top of the crate with the words, "COMB HONEY—HANDLE WITH CARE. KEEP FROM HEAT."

Two or more cases can be packed together in a larger crate in the same way. The larger crates should have handles on them to make it easy for the employees of the express company to handle the shipment.

The following paper was discussed.

THE HONEYBEE IN RELATION TO ALFALFA IN CALIFORNIA

By GEORGE H. VANSELL, *Davis, Calif.*

ABSTRACT

Nectar secretion in plants is a problem not well understood. Alfalfa constitutes one of the major sources of honey over much of the United States and at the same time great variation in secretion is observed. Extremes of climatic conditions and altitude in California are great, and as to be expected nectar secretion is affected materially. The six leading alfalfa honey sections of the state are listed with notes concerning the honeys.

The factors influencing nectar secretion in plants are very imperfectly known. Beekeepers have long noted variations in available nectar but as a rule they have been unable to contribute to our knowledge concerning secretion. Plant physiologists have apparently lacked sufficient interest in bees to undertake extensive studies from their scientific point of view. Of late years the problem has been attacked by several entomologists but they too are discovering that their training is inadequate for the solution of this problem.

Alfalfa constitutes a source of nectar over much of the United States, while in many places it is not visited by bees except meagerly. It may be safely stated that whenever nectar is present in the blossoms bees visit them, so the problem is purely one of secretion. Many theories have been formulated as to the various causes for this condition: the most popular one has to do with changes in atmospheric pressure.

The ecological conditions present in California are so varied that a record of the actual status of alfalfa as a source of nectar with different sections may prove of interest to entomologists interested in apiculture. Rainfall varies from approximately 0 to 100 inches, great extremes of temperature prevail within short distances, the highest and lowest altitudes in the United States are here within 90 miles, and soil types often change completely within a few rods. Not only does nectar flow vary widely under different conditions of time and location but the resulting honey also shows great color variation. No explanation of the facts herein recorded will be attempted at the present time. There are six distinct areas in which alfalfa is of importance for honey production. The many other places in which it is grown need not be mentioned except for the sake of completeness. The producing areas are in order of importance, the great valley (San Joaquin and Sacramento), Imperial Valley, Palo Verde Valley, northeastern plateaus, Shasta Valley, Antelope Valley, and formerly the Owen River Valley. In all these places the alfalfa is grown under irrigation.

The Great Valley lies from a few to four hundred feet above sea level. Much honey is produced particularly in the upper San Joaquin Valley and west of Stockton. The honey grades from light amber to very light amber. Alfalfa is of much less importance in the Sacramento Valley than in the San Joaquin, both on account of a smaller acreage and a meager nectar flow. The Imperial Valley is considerably below sea level. The honey is quite dark. The flow is long and continuous through the summer. An abundant supply of water is available and high temperatures are the rule. The Palo Verde Valley section of Riverside County is much like the Imperial Valley except that it is slightly above sea level. Much alfalfa seed is produced there so that bees have abundant opportunity for gathering nectar. The plateaus of the northeastern part of the state about Honey Lake and elsewhere, are quite high,—around 5,000 feet. The nectar flow is very rapid but a comparatively short season prevails. The honey is water-white. The same may be said of the Shasta Valley region except that the elevation is somewhat less. The Antelope Valley is light amber in color. The elevation of the region is around 2,500 feet. Where the crops are allowed to blossom freely nectar is abundant. The alfalfa along the coast is not considered of importance for nectar. Coastal conditions in California indicate coolness on account of the prevailing winds and cold ocean water.

The matter of pollination of the seed crop alfalfa does not bother the alfalfa grower particularly because beemen are anxious to concentrate their bees about seed alfalfa fields. The set of seed seems to be satisfactory generally.

Region	Altitude	General Color of Honey	Summer Conditions	Season	Part of State
The Great Valley	25–400 ft.	Light amber to very light amber	Warm to hot	Long	Central
Imperial Valley	Below sea level (Salton —202 ft.)	Amber to light amber	Very hot	Very long	Southeastern
Palo Verde Valley	328 ft. (Glamis)	Amber to light amber	Very hot	Very long	Southeastern
Antelope Valley	2349 ft. (Lancaster)	Light amber to nearly white	Warm	Long	South-central
Little Shasta Valley	2761 ft. (Gazelle)	White	Warm	Short	Northern
Northeastern Plateau Valleys	4440 ft. (Alturas)	White	Variable, hot and cool days	Short	Northeastern

Considerable discussion was centered around the varying textures of sugared honey.

Another discussion was the importance of acreages of sweet clover, and the honey production based on the price of sweet clover seed which governed the acreage planted.

Dr. Millen gave a brief report of Dr. Tanquary's paper on this subject delivered at a previous beekeeper's session.

John M. Davis, Spring Hill, Tenn., discussed Methods of Queen Rearing Used in the South.

The work of Dr. Watson in artificial insemination was discussed in regard to its practical applications in the queen rearing business.

The Secretary called attention to the importance of the early submittal of papers to Mr. Collins, that this year only a few papers had been sent in for publication in the regular program. He implored co-operation with the new Secretary by helping in this regard.

THE LESSER CORN STALK-BORER (*ELASMOPALPUS LIGNOSELLUS* ZELLER) INJURING SUGAR CANE IN CUBA[1]

By H. K. Plank

ABSTRACT

The lesser corn stalk-borer occurs in northern Camagüey Province, Cuba, in young sugar cane, causing "dead hearts," and in two weed grasses. It was most injurious in burned fields. The article describes the insect and reports observations on its life history.

During the season of 1927, a stalk-borer known in the southern United States as the lesser corn stalk-borer (*Elasmopalpus lignosellus* Zeller) was found injuring young ratoon sugar cane at Central Jaronú. The injury resembled that of the moth stalk-borer (*Diatraea saccharalis* Fabr.) in young sugar cane, producing the symptom known as "dead heart." Determinations were made of the larvae and pupae by Mr. Carl Heinrich and of the adults by Dr. Wm. Schaus of the United States National Museum.

The insect is referred to by Mr. Van Dine[2] as an undetermined species of Phycitinae. He states that the injury occurred in young cane, at the base of the shoots and often extended below the surface of the ground. His observations were made at Central Baraguá.

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[1] Scientific Contributions No. 11. Tropical Plant Research Foundation. From the Cuba Sugar Club Experiment Station, Central Baragua, Cuba.

[2] Van Dine, D. L. 1926. A list of the insects affecting sugar cane in Cuba. Trop. Plant Research Found. Bul. 3, 16 p.

The species has long been known in the United States, where its injury to corn and related plants is often serious. Messrs. Luginbill and Ainslie[3] record beans, corn, cowpeas, chufa (*Cyperus esculentus*), goose grass (*Eleusine indica*), Japanese cane, Johnson grass, milo maize, peanuts, sorghum, sugar cane (at New Orleans, La., June 16, 1924, by Mr. T. E. Holloway), turnips and wheat as host plants.

In Cuba it has been found developing in sour grass or "rabo de zorra" (*Valota insularis*) that was growing between the rows of sugar cane in the infested fields. It is also interesting to note that goose grass or "grama de caballo" (*Eleusine indica*), reported as a host plant of this insect in United States, is a common grass in guardarrayas of the cane fields in Cuba.

The known geographical distribution of the lesser corn stalk-borer is confined to the Western Hemisphere. It is apparently well distributed throughout South America, having been recorded from Colombia, Venezuela, Brazil, Uruguay, Argentine and Chile. It probably occurs also in Mexico and has been reported from the Bahama Islands. It has also been reported from Porto Rico and British Guiana. In the United States it is distributed over practically the entire southern half, having been reported more or less injuriously abundant in the territory south from eastern Massachusetts to southern California.

In a letter to the writer, Mr. B. A. Bourne of Canal Point, Florida, stated that, during the spring of 1927, his seedling canes were seriously injured by a borer which was identified for him by Mr. August Busck of the U. S. National Museum, as the lesser corn stalk-borer (*Elasmopalpus lignosellus* Zeller).

The damage to sugar cane in Cuba caused by the lesser corn stalk-borer was found to be confined almost exclusively to fields in which the trash had been burned off. Four to five crops had been harvested from these fields and the infested plants were young ratoons which had come up after the field had been burned. The burning took place about one month after the crop had been harvested and destroyed all of the young shoots which had started growing as well as the grasses in these fields. In the adjacent and nearby unburned fields, only three very small infested shoots were found during the entire time that observations were being made.

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[3] Luginbill, Philip, and Ainslie, Geo. G. The lesser corn stalk-borer. U. S. Dept. Agr. Bul. 539, 27 p., illus.

Usually a number of small holes were found in the infested stalks, sometimes distributed up and down the sides but in most cases located near or just below the surface of the ground. These holes were about 2 mm. in diameter, or about the caliber of the point of a lead pencil. As a rule, one hole, at or near the surface of the ground, was found to contain a little frass, or excrement, mixed with silky threads (Fig. 28). In the very small shoots usually only one hole was found which was located at about the surface of the ground. Since less than 10% of the infested shoots were found to contain borers, and since in no case was the pupa found in these stalks, it is evident that the majority of the borers spend most of their time in the silky, tubular run-way outside of the stalk.

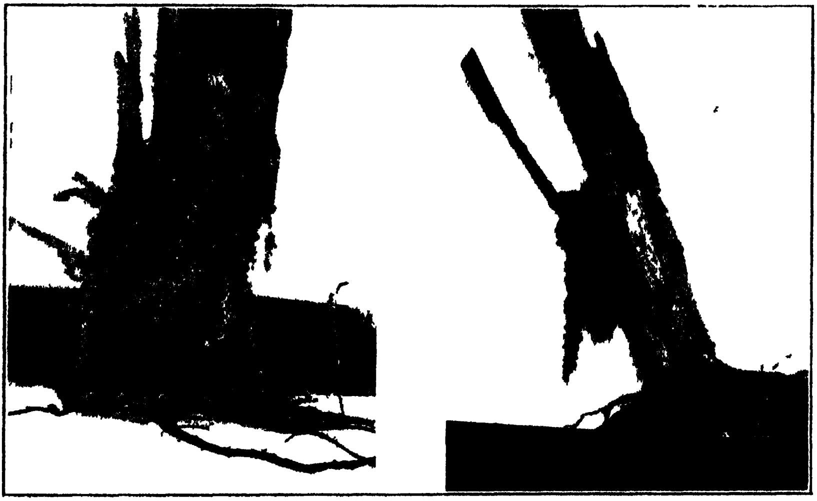

FIG. 28. Silky tubes of the lesser corn stalk-borer, at base of sorghum stalks. (From Luginbill and Ainslie).

The highest infestations were found in May and June, about a month or so after the trash on the field had been burned. The largest percentage of shoots infested amounted to 62.1% with an average of 14.28 per stool. The next was 55.1% with 7.72 per stool. An examination two weeks later showed no increase in the intensity of the infestation but there was a comparatively large increase in the number of shoots due to ratooning stimulated by the attack of this insect. While the largest average number of stalks per stool found infested by the lesser corn stalk-borer was slightly over 14, a number of stools were encountered in which all the shoots had been killed. Examinations made several months later in these same fields showed a general weakened condition of the stools, doubtless due to the excessive ratooning. In some cases the stool died as a result of its inability to put out more new growth.

The injury by the sugar cane moth stalk-borer (*Diatraea saccharalis* Fabr.) in these and adjacent fields was not found until the ratoons had been growing for more than 1½ months, from which time it steadily increased up to 23.25%. By this time practically all evidence of the infestation by the lesser corn stalk-borer had disappeared.

The borers observed were slender, bluish-green caterpillars which wriggled very actively when disturbed. They were not noticeably hairy. When full grown they measured a little more than one-half an inch in length. The head was small, dark brown or black, and the color of the first segment, or joint back of the head, was black. While the color of the body was quite variable, the back was deep blue-green, shading to lighter blue-green on the sides, and to a still lighter color underneath. Across the back and sides of each segment, near the hind margin, there was a dark brown band more or less irregularly fringed on its front edge with lines of the same color. (Fig. 29).

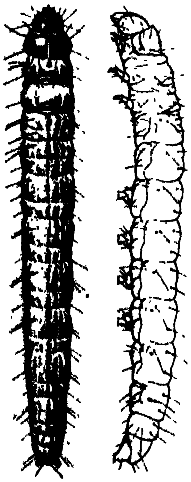

FIG. 29. The lesser corn stalk-borer: Larva. Greatly enlarged. (From Luginbill and Ainslie).

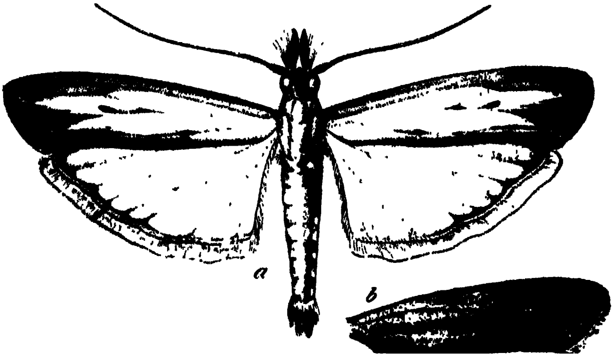

FIG. 30. The lesser corn stalk-borer: *a*, Male moth; *b*, forewing of female moth. Greatly enlarged. (From Luginbill and Ainslie).

No eggs were secured and all efforts to rear the very small larvae found in the infested shoots failed. No approximation can, therefore, be made as to the length of the larval period. It was observed that, among the 9 borers collected in the field and used for rearing adults in the insectary, the average feeding period was five days. In the case of one larva, however, 13 days elapsed before it changed to the pupal stage.

It is quite evident that the pupa, or chrysalis, is formed outside of the burrow made by the larva in the small shoots. Pupation may possibly take place in the silky tubular run-way near the base of the stalk or in the loose soil nearby. From 6 to 8 days was required for the pupal stage.

The only adults which have been seen were those which were reared in the insectary, in spite of the fact that a diligent search was made for them in the infested fields. The reared adults were small, inconspicuous moths measuring a little less than half an inch from the tip of the head to the tip of the wings while at rest (Fig. 30). They were of two different colors, that of the males being yellowish-brown to fawn while that of the females was almost uniformly dark brown to black.

The attack of this insect appears to be confined to young cane and in the inspection of young cane for the common moth stalkborer, based on the number of "dead hearts" found, an examination should be made of the shoots to determine whether or not the lesser corn borer is present. Otherwise rather serious borer injury to the crop might be indicated and the infestation of the common borer be really unimportant. The activity of the lesser corn borer and its habit of sheltering outside the tunnel in the shoot would prevent any benefit from the removal of the "dead heart" shoots. The observations made thus far indicate that the infestation of the lesser corn borer was severe in the fields that had been burned over and comparatively slight in the cane protected by a covering of trash. This seems to show that the trash covering is not favorable for this development of the insect. Several factors may be involved in this condition. The blanket of trash serves to suppress the weeds and such a check to the alternate grass host plants of the lesser corn borer may prevent its development reaching serious numbers. Further, the burning may destroy the parasites of the insect that would otherwise keep it in control, or the trash may be a protection to the base of the young shoots against the attack of this borer.

It is of interest to note that the infestation of the lesser corn borer does not persist in cane. It is confined to the young shoots and stimulates excessive ratooning. Under favorable conditions of moisture it is probable that the serious injury is the check to growth. Where this insect is observed, it will be found profitable to stimulate growth by cultivation, particularly under dry weather conditions, so that sufficient young ratoons will be saved to insure a stand.

FOURTH SHADE TREE CONFERENCE

At the Fourth Shade Tree Conference held at Washington, D. C., March 22–23, 1928, two features of the program were of vital entomological interest to all tree workers. One was the paper presented by Mr. William Middleton on "Factors Affecting Outbreaks of Shade Tree Insects," and the other was the round table discussion on "Oil Sprays" led by Dr. W. E. Britton. A tabulated summary of the latter has been prepared from the data collected from the tree men present at the meeting. This summary with Dr. Britton's opening remarks and Mr. Middleton's paper are published in this issue. (Ed.)

OIL SPRAYS AND OIL INJURY

By W. E. Britton, *New Haven, Conn.*

At the present time there is a decided tendency toward the increased use of oil sprays on shade and orchard trees. These sprays are of moderate cost, have good covering power, good penetration, and are easy to apply; therein probably lies the chief secret of their popularity. This increased use has developed in spite of the many records of oil injury to trees. Experience in nearly every one of the northeastern states shows that, under certain conditions, trees have been injured by the application of oils. Undoubtedly some of these injuries have resulted from an over-wide application of oil sprays. The manufacturers have urged their use as a remedy for too many tree troubles, and owners are only too willing to fall in line, especially after having used oils successfully for the control of certain insect pests. Of the fruit trees, peach and Japanese plum are regarded as being particularly susceptible to oil injury, and apple trees have been seriously injured in certain cases. Among the shade trees, sugar maple seems to be the most susceptible to oil injury, though whitewood or tulip tree is occasionally injured.

Up to this time no more effective dormant sprays have been developed than the miscible oils for destroying the eggs of the European red mite, *Paratetranychus pilosus* C. & F., the clover mite, *Bryobia pretiosa* Koch, and probably of the tree red spider, *Paratetranychus bicolor* Banks. Apparently the miscible oils are somewhat less effective in killing the eggs of aphids and some other insects than in destroying mite eggs.

Oil sprays now being used are of two general classes: (1) miscible oils, and (2) emulsions.

Strictly speaking, miscible oils are emulsions when diluted with water for application, but they are prepared in such a manner that the oil and the emulsifying agent form a clear stock solution and may be kept in that form until diluted with water, when they become milky. The miscible oils on the market may be roughly divided into the following four groups according to the oils used and their emulsifying agents:

1. Lubricating oils with sulphonated vegetable oils and alkali (Scalecide);
2. Sulphonated mineral oils, with alkali (Sunoco);
3. Lubricating oils, with soap dissolved in phenols (Carboleine, Victor, Wilson's, etc.)
4. Lubricating oils, with soap dissolved in alcohol.

In general it may be stated that miscible oils containing alcohol and phenols are more apt to injure trees than the sulphonated oils. However, none of the miscible oils can be considered safe for application to foliage, but all of them at the proper dilution will kill insects.

Among the emulsions is our old friend, kerosene soap emulsion, which has come down to us from former generations of entomologists, and many new emulsions developed during the past few years. Some of these require "red engine oil," a term without meaning unless specifications are given.

One of the most effective is the Government potash fish-oil soap boiled emulsion, made as follows:

Lubricating oil	2 gallons
Potash fish-oil soap	2 pounds
Water	1 gallon

Boil together until the soap is dissolved, but do not allow the oil to boil over into the fire. Churn vigorously through the small nozzle of a force pump until the mixture thickens on cooling. Six gallons of this stock in 94 gallons of water will make a four per cent spray.

The emulsions may be used on foliage at the proper dilution, and in general require only about half as much oil as the miscible oils to be of the same effectiveness. Yet, under certain conditions of temperature and humidity, some injury follows the application of emulsions, and it seems reasonable to suppose that the safest emulsion will finally be made from one of the "white oils." From a high-grade crude oil, the lighter oils such as gasoline and kerosene are distilled off, and the residue (or sludge) is treated with sulphuric acid. From this treatment there separates a clear liquid called "white oil" which is the portion

TABULATED REPORT OF CONFERENCE QUESTIONNAIRE ON OIL INJURY

DECIDUOUS TREES

Kind of Tree	Sprayed with Oil	Injury	Form of Injury	Type of Oil Spray	Locality	Month Applied	Temperature Conditions	Moisture Conditions
Ash	Yes	No						
Beech	Yes	Yes	Killed bark on trunk	Miscible	Cleveland Ohio	March		Dry
Birch	Yes	No						
Elm	Yes	Yes	two sprayings retarded leaves 10 days	Miscible	Providence	April	40°	Fair
Hackberry	Yes	No						
Hickory	Yes	No						
Horsechestnut	Yes	No						
Linden	Yes	No						
Magnolia	Yes	Yes; 1 case						
Maple, Sugar	Yes	Yes;	buds and wood killed		Ohio	March		
Silver	Yes	No						
Red	Yes	No						
Japanese	Yes	Yes						
Oak, Pin & Red	Yes	Yes		Crude Oil				
Poplar	Yes	No						
Sycamore	Yes	No						
Tulip	Yes	Yes						
Willow	Yes	No						

CONIFEROUS TREES

Kind of Tree	Sprayed with Oil	Injury	Form of Injury	Type of Oil Spray	Locality	Month Applied	Temperature Conditions	Moisture Conditions
Arborvitae	Yes	Yes, at dormant strength.[1]						
Balsam fir	Yes	Yes, slight			Ohio			
Douglas fir	Yes	Yes						
Hemlock	Yes	Yes	Burning	2% White Oil Emulsion	Ohio			
Pine, Mugho	Yes	Yes	Burning	Miscible	Providence R. I.	April	40°	Fair
Retinospora	Yes	No						
Spruce[2]	Yes	Yes	Burning	White Oil Emulsion	Ohio	August		

[1] No injury with 2 per cent white oil emulsion.

[2] One per cent white oil emulsion on foliage in August. Norway Spruce is particularly susceptible to oil injury.

insoluble in sulphuric acid. It is the most inert or neutral of all the oils and is on the market under various trade names such as "Nujol," "Markol," "Alboline," etc.

The emulsion now sold under the name of "Volck" is a white oil emulsion, and in general it may be considered as a good product, far safer than most other proprietary oil sprays. But even "Volck" may cause injury under certain conditions, and weak trees are especially liable to exhibit injury even where there is no injury to vigorous trees.

SOME FACTORS INFLUENCING OUTBREAKS OF, AND THE CONTROL OF, SHADE-TREE INSECTS

By WILLIAM MIDDLETON, *Associate Entomologist, Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

Insect infestations of shade trees present complex problems. These infestations are best prevented and controlled when we carefully consider all of the factors involved. These factors include climate or weather, the conditions under which the trees were grown and are growing, and many features of insect behavior. Today, with the steady improvement in the work of the tree expert, as regards both knowledge and technic, it is important for members of this profession to have a broad view of their problems. They should strive toward the prevention of tree-insect troubles as well as their control and endeavor to aid in the accumulation of information on shade-tree insects that will be available to all. The means for this accumulation of data lie in the full study of all phases of every problem and the recording of the information thus obtained.

For years the methods of work and the details of the biology or life history of shade-tree insects have been studied as a guide to control. This has been important work and without it little could ever have been accomplished Two types of useful data have been obtained through these studies. One relates to the normal cycle of activities of the species, involving the whole picture of the insect's life. The second is a collectoin of miscellaneous notes on insect behavior and on a variety of interrelationships. It is these notes on insect behavior and the various interrelationships that I would discuss at this time. The selection of this topic was made for two reasons; first, because some of these data are extremely valuable as an aid in combating insects and, second, because we can more easily help one another in acquiring data of this kind than in acquiring the whole life history of species.

The entire life cycle of an insect demands close attention to that species over a considerable period of time at one or several places.

Useful notes on behavior and relationships often can be obtained easily and rapidly by careful observers. This is especially true if the examinations of insect infestations are systematic and thorough and if existing conditions and the history of the material are carefully gone into.

Several broad groups of conditions that are important will be reviewed, with illustrative examples. These groups are (1) *climate* or *weather* (rainfall, frosts, etc.); (2) *normal growing conditions of plants* (filling in, grading, etc.); (3) *special behavior of insects* (adult and larval activity, cocooning or resting methods, etc.).

WEATHER AND INSECTS. For a long time weather has been recognized as an important factor in tree growth and also in insect abundance and distribution. Our foremost entomologists have been adding steadily to our knowledge of the importance of climatic or weather factors to plant growth and insect infestations. The movement of insects in the air at various altitudes and the influence of winds on their distribution are important examples with which you are no doubt familiar. Possibly less familiar are some other comparable observations.

The hickory barkbeetle (*Eccoptogaster quadrispinosus* Say) is probably the most important insect enemy of hickory trees. Some years ago Dr. E. P. Felt (1914) and Dr. M. W. Blackman (1924) published articles in which they showed the existence of an apparent connection between deficiency in rainfall and infestations of this beetle. Several years of deficient rainfall not only appear to affect adversely the vitality of the trees, but, what is even more significant, seem to bring about conditions in the trees extremely favorable and attractive to the beetles. This association of semi-drought conditions with infestations of this barkbeetle has an importance for us. It should lead to anticipation of hickory barkbeetle infestations and to preventive measures.

The methods of prevention of damage by the hickory barkbeetle (based on the observations made) depend upon the effect of an increase in rainfall on infestations in progress. This effect of increase in rainfall is very interesting and shows decidedly useful possibilities. Excess moisture produces an increase of the water in the plant tissues and tends decidedly to check the infestation, especially early in the attack.

We find indicated, in these studies, a course of procedure applicable both in prevention and in control. The elimination of water shortage through artificial application during dry periods, and copious supplies of water during the early stages of barkbeetle infestation, promise a considerable reduction of hickory mortality due to this pest.

Furthermore, infestations by barkbeetles are built up, and when the insects become abundant their virulence increases, or in their greater numbers they are able to, and will, attack vigorous trees. This places a special premium on the early control of outbreaks and on preventive measures.

The pine barkbeetles of the eastern coastal plain and the South(*Ips* spp. and *Dendroctonus frontalis* Zimm.) also seem to show a responsiveness to rainfall deficiency. The Ips are well known to prefer trees of lowered vitality, and the southern pine beetle shows a periodicity in abundance and a variation in the virulence of its attack. Pines suffering from semi-drought conditions are frequently infested by both Ips and the southern pine beetle. Impairment of vigor of the tree may be the chief feature of attraction to the insect, but it is also highly probable that trees suffering from insufficiency of fluids offer optimum conditions for the rearing of broods. Dr. F. C. Craighead (1925) pointed out an apparent correlation between deficiency of rainfall and the abundance of the southern pine beetle in destructive numbers. He also found that heavy precipitation while the young broods of the beetles were developing under the bark results in a very heavy and effective percentage of mortality. The role that rainfall plays in infestations of these pine barkbeetles is of considerable importance and the knowledge of this should lead to a reduction in losses. Again, applications of water during dry periods offer hope for the prevention of attack and in the early stages of an infestation give possibilities of control. Of course this method of treatment is feasible only under ornamental tree and park tree conditions.

With reference to the pine barkbeetles, weather or climate is also important from another angle. During the active period of the beetles (an activity largely, possibly entirely, controlled by temperature) pine timber-cutting operations, pine lumber, and even the turpentine in paint, show certain attractive or concentrating potentialities. The beetles tend to be more injurious in the neighborhood of such work and material. This leads to the recommendation of cutting and burning infested trees during the winter in the eastern part of the United States and especially among ornamental and park pines.

Temperature (probably in combination with humidity) sometimes plays a good role as well as a bad role. I have found periods of continuous high temperature in nature to be fatal to certain insects. During the summer of 1918 in Virginia near Washington, D. C., there was a spell of hot weather of approximately a week's duration. In this spell a maximum of 106°F. was reached while the minimum was 68°F. A large number of defoliating larvae, especially sawfly larvae, died during this hot period. One species of sawfly (*Cladius isomerus* Nort.), in which I was particularly interested at the time, remained scarce for the rest of the year.

The controlling effect of hot, dry weather on plant lice has also often been noted. This disappearance of aphids may not be a direct controlling effect; indeed, it may not even be a controlling effect at all. The disappearance of aphids from shade trees in hot weather may be due to a change or alternation of host plant. Alternation of hosts is now known to occur among certain species of aphids and undoubtedly occurs among many species for which it is not yet recorded. As examples of alternation of host among aphids infesting shade trees, attention is called to the maple-alder blight aphid which leaves maple for alder in the early summer, and the elm leaf-curling and the elm leaf rosette-forming aphids, *Eriosoma lanigerum* Riley, *E. americanum* Hausm., and other species, of the genus *Eriosoma*, which migrate from elm to apple, Amelanchier, Crataegus, Ribes, and possibly other plants. Such a summer migration could easily appear to be an effect of hot-weather control.

Again, dry, warm weather could very well favor the parasites and other natural enemies of aphids, and the control effect, while possibly primarily due to weather, is indirect through its improvement of conditions for parasites.

The sun's heat is being used as a means of producing the death of certain barkbeetles in some of the big forest-insect control projects of the West.

The character of weather occurring in fall, winter or spring is also looked upon as an item of great importance in determining the entomological problems of the year. Periodicity in abundance and the sudden disappearance or tremendous reduction in numbers of a species often depend upon factors other than parasitism or disease. We find certain relationships in abundance between insects—some years one group of species will be abundant, at other times other groups. Overwintering is a critical phase of insect life, and response to temperature on the part of insects is so blind that sudden changes in temperature, with alternate freezing and thawing or other unfavorable conditions must often play havoc with insect populations. The indications are that discoveries extremely useful in the prediction of epidemics and probably in the control of injurious species will be made in this field before many years.

These notes are presented in argument for observations and records of climatic factors prevailing during an infestation or its subsidence, and also to show the value of an examination into the weather of preceding years as a part of the case history.

THE NORMAL GROWING CONDITIONS OF PLANTS AND INSECTS. Let us now turn to a consideration of the normal or natural growing conditions of trees. Unquestionably trees grow best and with greatest vigor under natural or favorable conditions. These conditions include, first, the specific requirements of the tree which control its distribution in nature and, second, a natural chance to obtain its essentials from its surroundings and to adjust itself to these surroundings even if planted in a location where it would not naturally have occurred. We will, I believe, also agree that a tree growing under optimum conditions has fewer, or less serious, insect problems.

For some years the elm borer (*Saperda tridentata* Oliv.) has been growing in importance as an elm insect. Reports of injury have reached us from many places east of the Rocky Mountains. This trouble has led to more or less consideration of the problem and at one time to a broad series of observations. Several facts stood out prominently in these observations. One was that elms were not thriving in some places, even in the absence of this borer. Another was that the borer did not affect vigorous, unwounded elm trees. The whole picture presented by the studies showed that elms planted on high, dry ground, elms in cities well surrounded by concrete or other materials impervious to water, and trees suffering from severe root and trunk injuries, were especially subject to the elm borer's attack; and on the other hand those not so situated or injured, and those not defoliated, were growing more vigorously and were not subject to injury.

Several years ago I had an interesting experience. I was called to advise on some supposedly serious entomological features of certain shade trees of a Virginia estate. These troubles were confined to a long avenue of trees lining the approach to the mansion. The estate lay in a valley near a good-sized hill. The insect difficulties consisted of a few scales, aphids, ants and, of apparently greater importance, borers. Careful examination of the trees showed an extremely interesting situation. All or most all of the trees were by report approximately the same age and size at the time of planting, but the growth had been exceedingly irregular. Some had died and had been removed and replaced. The borer work was insufficient to account for the differences in size observable, and the dead trees were gone and could not be examined. After some false starts it was finally discovered, through the investigation of the general growing conditions, that in places rock closely approached the surface of the soil. The shallow soil curtailed normal root expansion and in hot dry weather must have caused considerable root injury through water shortage or increased soil temperature. The trees which had died from time to time probably were killed as a result of a complication of conditions rather than by one simple cause.

Many times severe borer injury follows a sudden and extensive change in the environment of trees. Trees, like animals, adapt themselves to, and grow old and cranky in a certain environment. They thus lose considerable of their plasticity or powers of adaptation. When this occurs and a change comes, the vigor of the tree suffers. Often insects kill these weakened trees. Sometimes the trees are actually dying from the changes and only offer ready breeding material for the insects.

The association of insect attack and severe change of conditions, however, is an important and positive one. Several types of examples will be used to illustrate this.

Real-estate development companies often find themselves confronted by an unlooked-for problem. They have obtained a wooded tract and have proceeded to subdivide it into lots and to remove most of the trees. The trees left are selected, desirable individuals that enhance the value of the property. But these trees begin to be attacked by borers and die. This is a very common occurrence. Several years ago I found this same condition at an army post. Here a small wooded area had been cleared for a parade ground, leaving a fringe or margin of trees around the field. The trees in this border were borer-attacked and dying. The cause seemed clear. The trees had grown and adjusted themselves to a set of conditons in which the ground was shaded, leaf-covered and moist. This had suddenly been changed. The sun shining down on the now bare ground had dried and baked it. Water difficulties developed, or the roots suffered from the change in soil temperature or through the removal of near-by trees, and the remaining trees rapidly weakened and soon became borer-infested.

Another example of this interrelation of borer attack and the growing conditions of trees, one that is also very common, occurs where trees are filled around in grading. The changing of contours in landscaping and building is frequently necessary or desirable. But sometimes it works great hardships upon trees. Not infrequently I have found the two-lined chestnut and oak borer (*Agrilus bilineatus* Web.) attacking and killing oak trees so handicapped.

Under this heading we should also place the insect injuries following transplanting. Here there are two things to be considered. Many trees probably would survive transplanting but for the fact that during their period of recovery they are attacked and killed by insects. Borers are the chief offenders, again. Pine, spruce, dogwood, maple and other trees are continually being purchased and transplanted. Even when the greatest care is exercised in this operation, loss of vigor follows. The tree thus becomes an attractive and easily killed prey for some species of borer. Species of *Ips* and other trunk-infesting engraver beetles, some of the twig barkbeetles, and even longhorned borers, attack and kill transplanted conifers. A flat-headed bark and wood borer attacks dogwood, and similarly a flat-headed borer and one of the clear-winged moths infest maple frequently under such circumstances.

The second consideration in transplanting involves the conditions under which it is proposed to grow the tree in its new location. Is it, for example, a rich, moist, shady bottom land, a high, dry, bald hill top, or a steep bank? Where the tree came from and where it goes and its requirements are intimately related with success in keeping it free of borers and of a vigor likely to sustain it under insect attacks. Here, too, we find problems in the abundance of a tree species throughout a locality which favors a multiplication of its enemies, and in the purity or character of mixture of a park or ornamental planting. Even under shade-tree and park conditions these considerations are important from an insect standpoint.

Defoliation also frequently leads to a condition apparently inviting to borers.

INSECT BEHAVIOR. Through detailed and lengthy studies of the life cycles of many insects and investigations of their control has come an appreciation of the value of certain phases of insect behavior. Unquestionably the whole story of an insect's life, its host's life and the various influences that bear upon it are the best foundation on which to erect the control of the insect. Yet seldom are all of these important data available. Occasionally we are forced to meet a problem almost if not entirely new. We meet these unfamiliar troubles best if we find in the new situation something or some things possessed in common with old and familiar problems. The most important common factors or "somethings" are interrelations between the insect, its host and its environment, and the habits, or instincts, or behavior of the insect.

Valuable information of the character referred to can be obtained readily by careful observation of the conditions prevailing in infestations and of the activities of the insects. Chief among these easily noted factors and one universally used is the manner of feeding by an insect. In determining control methods we almost invariably turn first to the advisability of spraying and consider immediately the so-called feeding habits and body protection of the insect.

On the following pages it is proposed to point out a few more examples of interrelation or behavior on the part of various insects which are very useful in control.

Some insects are by nature sun-loving in the adult stage. The metallic wood-borers (buprestids) as a group appear to be of this character. *Agrilus*, the genus to which the two-lined chestnut and oak borer and the bronze birch borer belong, seems to be especially so. The locust borer (*Cyllene robiniae* Forst.) is known to be sun-loving, and recommendations for the prevention of injury by it take this into consideration. Craighead (1919) finds that *dense* stands of locust with the weeds and underbrush allowed to remain are least subject to injury by this borer. In the few instances during the last few years in which I have seen bronze birch borer injury in the field, I have been struck by the existence of an apparent connection between injury and open growth and dry site. This relationship has been observed, also, by Dr. S. A. Graham of the Department of Forestry and Conservation, University of Michigan and probably, by others, so it seems worthy of attention and further study. The association seems the more significant when we consider that the two-lined chestnut and oak borer is more of a shade-tree and park problem than a forest problem and that it appears to be a more injurious pest following clearing-out and grading operations.

Information on the cocooning, pupation and overwintering behavior of insects is also useful. The female bagworm moth lays her eggs within the bag or sack in the fall and the eggs overwinter there. This forms the basis of the recommendation for picking and destroying the bags in fall, winter and early spring. The occurrence of overwintering egg masses of the gipsy moth and the white-marked tussock moth is used as one basis for the control of these species. Leaf miners often use their mines within the leaves as a place of overwintering, thus avoiding the necessity of deserting the leaves and finding or constructing some new protection. The white blotch oak leaf miner, *Cameraria hamadryella* Clem., and other species have this behavior. The sawfly leaf miner of birch, at present so abundant in New England, spins its cocoon within the mined leaf. Even some borers, such as the twig-pruners (*Elaphidion* spp.) and the twig-girdlers (*Oncideres* spp.), have an overwintering behavior of which we can take advantage in combating them.

Insect behavior is usually based on some very important necessity of the species. The urge of a species for dissemination is an important one, and is based on the need for an environment where the competition for food within the species will be less severe and where optimum conditions prevail and the chances for survival will be greatest. We usually find, in the adult, wings or other advanced and efficient means of locomotion, as well as an impulse to move about. Among some species, such as the white-marked tussock moth, the gipsy moth, cankerworms, the bagworm and others, the female moth is either wingless or a poor flier. To compensate for this lack of adult motility and to insure distribution, a wanderlust manifests itself in the caterpillar stage, usually after the feeding period is finished. Advantage has been taken of this habit in efforts at control through tree-banding methods.

For several years the foliage of beech trees in this region has been subject to a queer changing of color. The leaves became brown in the late summer over entire trees, and for awhile no definite reason could be given for the trouble. Careful observations showed that, associated with the browned foliage, there were occasional whitish shed skins on the underside of the leaves. The following year leafhoppers were found in great numbers on the undersides of the green leaves of these trees. Later, after the leafhoppers had disappeared, the discoloration became prominent.

Sometimes strange reports come to us. For instance, in the late spring and early summer of 1926 and 1927 I received a large number of inquiries as to the cause for the falling of twigs from oaks in this vicinity. An examination was made and the twigs cut off in leaf were found thick about the bases of the oak trees. A study of the ends showed that the work in severing the twigs was particularly crude and not recognizable as due to any kind of insect. An important entomological feature was present, however, for the severed twigs and the tree from which they fell were rather heavily infested by *Kermes* scales. Further observations showed that squirrels were the real pruners and that the scale was apparently the attraction for the squirrels, or rather that in feeding on the scales the squirrels often cut off the twigs.

It not infrequently happens that we are faced with a problem to which an entomological answer is sought but for which there is no insect answer. I remember an interesting and abundant injury to holly leaves—small perforations in the leaves, especially in the epidermis of the undersides of the leaves. The injury looked like the result of punctures by an insect ovipositor or beak. It proved to be nothing more than the damage wrought by the spines of adjacent leaves.

Conclusion. It is quite possible that these notes may be interpreted as indicating a somewhat lessened conception of the importance of insects. Such is far from the case. We should realize, first, that trees, as living things, face complicated conditions for living, just as we do. We should understand from this that it is rarely one solitary factor that brings about their death but a number of interrelated things. Certain functions or requirements and conditions of the tree itself, certain factors of the immediate and relatively permanent environment, certain conditions of climate or weather, various insects and their injuries and some disease or diseases may all have parts to play in the death of a single tree. In most cases one factor is the essential one, and with it removed the tree will continue its struggle to live. If two or three of the depressing factors are removed the tree may again attain normal vigor and conquer its other difficulties. Insects are very often one of these essential factors in producing the death of trees, and to see them in this light accentuates rather than decreases their importance. Then, too, when we consider their activities as an additional heavy strain placed upon the tree, they become the more important. We know that all trees are under the pressure of competition and are exposed to other adverse conditions, and that this is especially true of shade trees. Furthermore, we know very little of an individual tree's margin of safety.

Now, why do I talk to you of these things? What good can we derive from a discussion of things some of which, at least, you all know and about some of which no one knows anything? This paper is intended to show the importance, in our care of shade trees, of the following:

(1) A thorough analysis of all the conditions under which the tree and the organisms are operating.

(2) A review of the more important phases of the history of the plants infested and the organisms involved, in the particular neighborhood.

(3) The careful determination of the essential cause or causes of a tree's death.

(4) The accurate identification of all organisms causally involved, insect or fungus.

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Scientific Notes

An Inexpensive Method of Protecting Household Refrigerators from Ants. During the summer at Fresno, California, the invasion of houses by ants is a source of wide-spread annoyance.

Perhaps the most common procedure in keeping ants out of refrigerators is placing the castors in small pans of water or oil. A method of protection used by the writers with complete effectiveness during the past three years consists in *standing the castors in small metal pans filled with a dry mixture of whiting and flowers of sulphur*, in approximately equal proportions. The pans used were 4 inches in diameter and 1.5 inches deep. In several other cases where this method was adopted at the writers' suggestion, ants were effectively barred from refrigerators. The principal advantage of this method lies in the fact that the mixture remains effective over many months, despite the "caking over" of the surface. The writers have observed this mixture, without replenishing or disturbing, to remain effective through two entire summers, thus extending over a period of 18 months. Should the mixture in a pan become wet from any cause the pan must be emptied and filled with fresh materials. The cost of the sulphur and whiting required for four pans is trivial. The writers have not made a detailed study of the different species of ants concerned but the one most commonly involved has been determined by Doctor W. M. Wheeler as *Pheidole hyatti* Emery.

J. C. and M. S. Hamlin, *Tampa, Florida*

Turpentine Oil as an Attractant of the Wheel Bug (*Arilus cristatus* L.). During the course of tests conducted in an endeavor to secure an efficient repellent for the Japanese beetle (*Popillia japonica* Newm.), it was discovered that turpentine oil U. S. P. had a strong attraction for the wheel bug. The oil was used at full strength, 15 grams of the material being placed in a six-ounce tin. This tin was attached to a similar one containing a bran and molasses mixture with 5 grams of geraniol. Both tins were suspended from a branch of a peach tree. A few days after being placed in the field several wheel bugs were noticed on the can containing the turpentine oil.

Part of the procedure of the test was to change the position of the can on the tree daily, and such a change necessitated a movement of several feet. The wheel bugs followed the can to each new location and were noted only in its immediate vicinity. The turpentine oil was then moved to another tree some distance from the first and the insects soon appeared at the new location. Moreover, no more were observed at the first point.

The oil was placed in the field on August 19 and the first bug was seen on the can at 9:30 a.m. on August 21. The largest number observed at any one time during the day was seven. On the following day at 2 p.m. there were seven wheel bugs on the can and twelve on the foliage within a radius of one foot from the oil. For the next two days the number on or near the can ranged from ten to twelve at each observation. The can was withdrawn on August 25.

In order to ascertain whether or not the odor from the can containing geraniol influenced the response of the insects in any way, the turpentine oil was located at some distance from any other chemical. The wheel bugs soon noticed the change and readily moved to the new position. This clearly indicated that the turpentine oil alone was responsible for the attraction. At no time were wheel bugs seen at any other point in the orchard or in its immediate vicinity.

F. W. METZGER

Notes on *Phlebatrophia mathesoni* MacG. in Maine. (Hym.--Tenthredinidae). During the summer of 1927 trees of *Betula alba* and *B. populifolia* on Mount Desert Island, Maine, were found to have their foliage heavily infested with larvae of a leaf-mining Tenthredinid which agree with the characters of the larva of *P. mathesoni* MacG. as given by Yuasa in the Ill. Biological Monograph, VII, No. 4, 60, 1922.

The adult of this species was originally described by MacGillivray in 1909 (Can. Ent., 41, 245, 1909). It has twice been mentioned by Hewitt in his reports (Can. Expt. Farms Rept., 1910, 246, and 1912, 182), in which he gives some notes concerning its life history and mentions it as having been known to occur in Nova Scotia since about 1904. In his 1912 report Hewitt stated that it was extremely abundant in New Brunswick and Nova Scotia. So far as I have been able to determine, no record has yet been published mentioning this species as occurring in any part of the United States.

The following notes, taken in 1927, are supplementary to those given by Hewitt:

Adult—Observed in numbers on Mount Desert Island on June 30, on foliage of white and gray birch and on alder. One of the specimens taken has been compared with the type, by Dr. T. H. Frison, and found to agree with it. Oviposition—The egg is inserted in the marginal tissues of the leaf between the upper and lower epidermal layers. The tissues immediately surrounding the point of insertion become browned and dry, the presence of one to several of these browned areas being characteristic. On June 23 but few evidences of oviposition were noticed, but on July 3 they were common, the injury already being noticeable, even at a distance, on both white and gray birch. A few examples of this injury were found on alder. Adults were not seen on this later date. Larva—The larvae, on hatching, commence to mine the leaves, completely separating the epidermal layers by their feeding activities. The leaves become dry and brown where they have been mined, the injury being very noticeable. Larvae were found in the leaves from about July 10 on. They are Buprestoid in general outline, the thoracic segments being the broadest; the abdomen tapering posteriorly; the entire body flattened dorso-ventrally. They are nearly cream-white in color, many showing a very light greenish tinge. Hibernaculum—As stated by Hewitt, the larvae hibernate in a circular disc-like hibernaculum. This is formed by fastening the epidermal layers together and by lining the interior of the case with silk. This form was first found about the middle of September, the insect at that time being in the larval stage.

K. A. SALMAN, *Massachusetts Agricultural College*

Why Only Staminate Box-Elders Should be Used for Shade Trees. The Box-elder (*Acer negundo*) is a common shade tree in the parks and street parkings in the Southwest. It is a rapid grower, stands dry weather well and is suited to semi-arid conditions. Its use as a shade tree has been declining during recent years due mainly to the presence on the trees of large numbers of the box-elder bug (*Leptocoris trivittatus*).

In the fall of the year these bugs leave the trees and invade in swarms all nearby buildings, such as residences, barns and other outbuildings, seeking a warm and protected location for their winter quarters. At such times they find their way into houses in spite of screens on doors and windows and become a veritable plague to the housewives. This performance is repeated on their emergence in the spring during the alternate warm and cold spells, so common at that time of the year; finally they disappear entirely till the following fall. Sometimes a third invasion may occur during August when there is an over-supply of bugs on the trees. At this time the adults are mating and seeking places to lay their eggs, also for some unknown reason the immature forms leave the heavily infested trees and crawl on nearby fences and buildings. This moving about of the bugs may be due to their search for fresh food supplies.

For several years the writer has observed that this bug is present on only the pistillate or fruit-bearing trees. In the same yard would be both pistillate and staminate box-elders, sometimes with branches almost touching and yet the bugs would be found only on the trees having the fruit. There was evidently some good reason for this choice by the insects but no clue to the reason was found till this year.

On August the first, many pairs of these bugs were seen on the seeds of the box-elder where they were mating; two or three days later, hundreds of eggs were found. In every instance the eggs were laid on the fruit, usually in groups of 3–8, with only one bunch of eggs to each group of fruit. The eggs were glued flatwise to the side of the samara on the wing in the curve just below the seed kernel and at the edge of the midrib of the fruit. The eggs were light brown in color, oval in outline and measured about 1/16 inch by 1/32 inch in size. Even during the egg laying period many nymphs or immature forms of all ages were seen feeding on the succulent fruits. No eggs were found on the leaves of the first trees examined which bore the egg infested seeds, and no bugs of any age or eggs were found on the adjacent staminate trees. The use of the fruits for ovipositing and for food by the newly hatched young and even by the nymphs of all ages explains why this insect is usually found only on the fruit bearing trees.

About the middle of August fruit bearing box-elders in another portion of Albuquerque were examined, which were literally covered with bugs of all ages, many were leaving the trees as if seeking winter quarters. The adults of both sexes were very abundant while eggs had been laid on the *leaves* as well as on the seeds. The eggs on the leaves were usually attached to the underside and some leaves had 2–3 bunches to a leaflet. In this case the trees were so heavily overrun with bugs that the eggs were laid on leaves as well as fruits, but no bugs or eggs were found on the adjacent staminate trees in the same yard.

As a result of these observations it is evident that the presence of the bugs on the fruit bearing box elders is not an accident but is due to the fact that the tender and succulent fruits furnish food for not only the newly hatched young but the older nymphs as well, while the old tough leaves are rejected.

The above facts have an important bearing on the propagation and use of this tree as a shade tree in our cities, where the bugs become a nuisance at certain seasons of the year. Nurserymen should propagate this tree from cuttings and not from seed; by using cuttings from staminate trees they will have no fruit bearing trees for sale and this species could then be used for shade in our cities without any danger of the box-elder bug nuisance.

W. H. Long

Longevity of the Codling Moth Larva. Under natural conditions in the apple orchard, the overwintering codling-moth larva will pupate in the spring and the pupa in turn will transform to the adult within a few weeks. The following quotation is taken from pages 83 and 84 in Bureau of Entomology Bulletin 115, part I, U. S. Department of Agriculture, Life-History Studies on the Codling Moth in Michigan, by A. G. Hammar:

"An unusual observation on the duration of the larval stage of the codling moth was made in 1909 and 1910 by Mr. R. W. Braucher at Douglas, Mich. In the fall of 1908 a number of larvae were collected for rearing purposes and for studies to be made the following spring. Two of the larvae failed to transform in 1909 and both were alive the following spring, 1910. On April 30 one larvae had pupated; the other larva died June 24. The pupa, too, finally failed and was found dead July 18. Considering that the larvae left the fruit about September 1, 1908, or possibly much earlier, we find that one of the insects remained 20 months in the larval stage without taking food or water and that the other specimen remained 23 months in the cocoon as larva and pupa. The two larvae had made their cocoons in a large glass vial. They came under the writer's observation in 1910.".

"The ability of an insect to remain dormant for a whole season and to transform subsequently the third season may possibly occur more frequently than has been actually observed. Such an adaptation would be of particular advantage to the species in surviving adverse seasons."

In so far as is known to the writers, this is the only instance reported in which colding-moth larvae have survived two winter seasons. It seems possible, however, that if the further development of the larva were arrested through the use of conditions unfavorable to transformation, some individuals might live through two winters. With this in mind, 2,306 codling-moth larvae were collected in the fall of 1925 and allowed to spin their cocoons in wooden cocooning sticks. These were kept in an out-door insectary until March 6, 1926. They were then transferred to a cold-storage compartment in which a temperature of 32 degrees Fahrenheit was maintained.

On April 11, 1927, the larvae were removed from cold storage and again placed in an out-door insectary. The larvae were examined on the same day and 68 were found to be alive but in a weak condition. With the exception of one individual, all of the larvae died previous to pupating. One larva pupated but the moth never issued.

The writers are inclined to the belief that, in spite of the most adverse weather conditions likely to occur in an orchard, which would tend to prevent transformation and to prolong larval life, the codling-moth larva would have insufficient vitality to live through two winters and subsequently perpetuate the species.

E. H. Siegler and Luther Brown,
U. S. Bureau of Entomology, Sligo, Maryland

The Native Home of the Citrophilus Mealybug. It has been the belief of entomologists, practically from the time the insect was determined by Clausen to be distinct from the other species of mealybugs attacking citrus in California,that the citrophilus mealybug (*Pseudococcus gahani* Green) was not a native of this state or country, but that it was an immigrant from some unknown foreign land. The fact that when first discovered it was very much restricted in distribution, being known then only in the San Francisco Bay region and at Upland in Southern California, and its extremely rapid spread since that time, seemed to lead logically to that conclusion. Its freedom from parasites also seemed to be evidence in support of this view.

This insect having developed into one of the major pests of citrus in Southern California and into probably the worst pest of ornamentals in the Bay region, we have expended considerable effort in an attempt to discover its native home, since it was believed that if this could be done, natural enemies might be found there which would well repay the effort necessary to introduce them into the State. The insect has been recorded from England and Wales but not under such circumstances as to warrant the belief that it originated there. It was thought that, because of its early establishment in the vicinity of San Francisco, it probably originated in some one of the countries which maintain direct steamship communication with that port. Consequently Mr. Clausen, representing this department, made a careful search for the insect in Japan, Formosa, the Philippines and China in 1916 and 1917, but without success. Later, in 1925, Dr. F. Silvestri who spent 18 months for us in the Orient, was supplied with illustrations and specimens of the insect and requested to look out for this species. Diligent search by Dr. Silvestri in the countries visited by Clausen and in addition in Indo-China and the Malay Archipelago failed to reveal its presence.

About the only other countries maintaining direct steamship lines with San Francisco are Australia and New Zealand, and failure to find the citrophilus mealybug in the Orient left these countries as apparently the most likely places to search for it. Consequently about a year ago it was decided to send Mr. Harold Compere to Australia in a final effort to solve the problem of its origin. He arrived there in early October and had been in Australia scarcely a week when he cabled that he had found the citrophilus mealybug in Sydney. This discovery in itself would not necessarily indicate that it had originated there, since it could easily have been introduced into Australia from California. Further investigation, however, brought to light the fact that it is heavily parasitized at Sydney, by at least three different species of internal parasites which appear to be specific on this species. This, we believe, is very strong evidence in favor of the idea that the citrophilus mealybug is a native of Australia.

The practical importance of this discovery must, of course, await future development. While biological control of this species by use of the ladybird Cryptolaemus has given results quite as satisfactory as other methods of control have for the other major pests of citrus and at a much lower cost, those of us who have been associated with the development of this work have long felt the need of an effective internal parasite which would operate as Leptomastidea does on the common mealybug. The ideal control is preventive rather than curative. While heavy infestations of the citrophilus mealybugs are almost invariably rapidly brought into commercial control by the use of Cryptolaemus, it has not been so easy always to keep a light infestation from becoming heavy and thus causing injury. It has been demonstrated in the case of the common mealybug, that specific internal parasites are more satisfactory for this purpose than predators, since they are better able to search out and destroy isolated individual mealybugs. It is not too much to hope that at least one of these internal parasites be found by Compere in Australia will fill this need, so that the insectaries may be supplied with an additional, and very useful, weapon to be employed against this important pest.

HARRY S. SMITH, *Citrus Experiment Station, Riverside, Calif.*

Pollen Carriers on Summer Squash, *Cucurbita pepo.* For several years controlled pollination work on cucurbita pepo has been hindered to a slight extent by insects smaller than bees entering tied bags after artificial pollination of blossoms.

The extent of this damage is slight, about .2 of 1 per cent; but greater than careful work should afford.

Striped cucumber beetles (*Diabrotica vittata* Fab.) and ants were suspected as probable carriers so these have been compared with bees of both Bombus and Apis types in competition in open flowers thru the morning hours and from 3 to 4 P.M.

Specimens were caught by tweezers and dipped in 70 per cent alcohol on a microscope slide. This removed most of the pollen, at least all that might be expected to come off in contact with the stigmas.

Pollen grains were counted by the aid of either a hand lens or by a low powered microscope.

From the results in the summary table it may be observed that the striped cucumber beetle, is a carrier of squash pollen to such an appreciable extent that it could enter openings in closed bags too small for the entrance of bees and upset controlled pollinations.

In taking pollen during the month of August it was observed that on humid days or in the morning before the dew had disappeared much more pollen clings to the insect than during the less humid days or hours of sunshine.

It may be concluded: 1. that the striped cucumber beetle is a strong competitior with bees in the pollination of *Cucurbita pepo.* 2. that moisture aids in the distribution of pollen by insects.

SUMMARY OF NUMBER OF POLLEN GRAINS PER FLOWER

Time Means	7:30	8:30	9:30	10:30	11:30	3:30
Striped Beetle on ♂ blossom	104	48	66.7	138.6	23.3	1.1
on ♀	18	19.1	17	20	6.3	.3
Bumble Bee on ♂	980	449	394	294	187	—
on ♀	790	229.5	311	242	23	—
Honey Bee on ♂	51	232.2	1305	41	42	.4
on ♀†	11	918	675	43	5.5	0
Ants on ♂	—	—	182	8	—	.4
	No ants active					
on ♀	—	—	0	0	—	0

GEORGE B. DURHAM

Lime and Sodium Fluosilicate. In the past hydrated lime was recommended as a carrier for sodium fluosilicate. In the absence of moisture the lime carbonates and acts as a neutral carrier. Frequently dew is present on the plants at the time of dusting. Under such conditions the lime dissolves and reacts with the sodium fluosilicate to give the soluble calcium fluosilcate which may be the cause of foiagel injury. In the presence of moisture, a neutral carrier such as flour, talc, sulphur, and infusorial earth have been found much safer. The writer obtained considerable foliage injury with hydrated lime alone on wet cucumber foliage. If hydrated lime is the only carrier available, care should be exercised to apply the dust mixture when *no dew* is on the foliage. A dry dust that stimulates the "cleaning habit" appears more effective against adult bean beetles or cucumber beetles than dust wetted by dew or moisture.

Several firms are now in a position to supply the demand for a light sodium fluosilicate, among them being the Bowker Chemical Company, and the Nitrate Agencies, of New York City; and the J. C. Wiarda Company, of Brooklyn, New York. The latter firm also has a ready prepared dust composed of sodium fluosilicate, sulphur, and infusorial earth in equal proportions.

S. Marcovitch

Sonora Cotton Square Dauber (*Creontiades debilis* **Van D.**). This mirid bug, first observed injuring cotton (Hartsville) in the Yaqui Valley in 1925, proved very destructive in one field of 400 acres (Delfos 6102) in 1927. Present in very small numbers in June, they multiplied on cotton until by August 3rd it was estimated that 90% of the blooms in this field showed effects of the attack. Unlike the usual experience with Egyptian cotton (Pima) in Arizona, where squares fed upon by mirids (*Lygus* spp.) are usually shed, very little shedding of squares occurred. Possibly this retention of injured squares is a chracteristic of the cotton variety.

The principal damage was done to young bolls, some of which shed and others continued development in size but with interiors more or less completely ruined. An examination of bolls on August 3rd gave 60% with one or more locks showing damage. On the basis of locks it was estimated that 49% showed injury. A final estimate of the damage for the season made on September 15th showed that the crop in the 400 acre field which would probably have otherwise averaged 1½ bales per acre was reduced to a litle over ¾ of a bale per acre. The damage throughout the Yaqui Valley, where the total plantings were 3000 acres, amounted to 15% of the crop.

On Sept. 15th in the same locality where blooms showed that on Aug. 3rd 90% had been fed upon in the bud stage leaving characteristic damage toanthers and spotting of the petals, 92% of blooms were free from this injury, and the mirids were proportionally scarce.

Specimens of this pest have been examined by Dr. H. H. Knight who found them to be the above named species but not typical in coloration. He states that the species has been found working on cotton in Texas and Louisiana.

A. W. Morrill

European Hen Flea in Connecticut. On complaint of a tenant in Madison that his garden was overrun with fleas which had bitten a child and the ankles of adults, the place was visited on April 16, 1927. It appeared that droppings had been brought from a vacant henhouse on the premises and spread upon the garden, which was rather near the back door. Specimens of the fleas were collected and identified by Mr. M. A. Stewart as the European hen flea, *Ceratophyllus gallinae* Schrank.

W. E. Britton

MINUTES OF INFORMAL CONFERENCE ON THE CODLING MOTH HELD IN WASHINGTON, D. C., JANUARY 4, 1928

An informal conference was held January 4, 1928, in the office of Dr. A. L. Quaintance, Associate Chief of the Bureau of Entomology and chairman of the committee on cooperation of Federal and State workers on the codling moth, with especial reference to the spray-residue situation. This committee was appointed last year by the American Association of Economic Entomologists to formulate plans for cooperation investigations to be carried out by different workers during the season of 1927. The membership of this committee is as follows: Dr. A. L. Quaintance, chairman; Prof. Geo. A. Dean, Prof. P. J. Parrott, Prof. W. P. Flint, Mr. LeRoy Childs, and Dr. B. A. Porter

The conferees present at the informal meeting presented results of the work accomplished during 1927 and made suggestions for work during 1928. State workers present at the conference were:

Dr. T. J. Headlee, New Jersey Agricultural Experiment Station, New Brunswick, N. J.
Mr. H. N. Worthley, Pennsylvania State College, State College, Pa.
Prof. J. S. Houser, Ohio Agricultural Experiment Station, Wooster, O.
Prof. J. J. Davis, Purdue University, Lafayette, Ind.
Prof. P. J. Parrott, Agricultural Experiment Station, Geneva, N. Y.
Prof. L. M. Peairs, Agricultural Experiment Station, Morgantown, W. Va.
Prof. Leonard Haseman, University of Missouri, Columbia, Mo.
Mr. H S. McConnell, University of Maryland, College Park, Md.
Prof. W. P. Flint, University of Illinois, Urbana, Ill.
Prof. Geo. A. Dean, Agricultural College, Manhattan, Kans.
Dr. W. S. Hough, Polytechnic Institute, Winchester, Va.

Bureau of Entomology workers present were: Dr. A. L. Quaintance, Dr B. A. Porter, Dr. C. H. Richardson, Dr. F. L. Campbell, Dr. N. E. McIndoo, Dr. A. Peterson, Mr. E. J. Newcomer, Mr. A. J. Ackerman, Mr. E. H. Siegler, Mr. L. Brown, Mr. R. F. Sazama, Mr. R. E. Snodgrass, Mr. E. R. Van Leeuwen, Mr. G. A. Runner, Mr. J. A. Hyslop.

Dr. R. C. Roark, of the Bureau of Chemistry and Soils, and Dr. W. A. Hooker, of the Office of Experiment Stations, were also present.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1928

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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Aiding nature in re-establishing the balance between various forms of life is a logical method of insect control and one with possibly a much wider application than has been suspected. One of the latest is the experimental dissemination of a tabanid egg parasite (see Circular 18, U. S. Department of Agriculture, Jan. 1928) apparently with most promising results.

The citation of the above circular raises a question of more than passing bibliographical interest. There are in the Bureau of Entomology of the Department of Agriculture an exceedingly varied series of publications and the same is true to some extent of similar publishing agencies in certain states. There are undoubtedly reasons for these conditions, and yet a variety of series greatly complicates the labor of citation, increases difficulties in both indexing and filing and adds to the burden of the scientist. Keep series as uniform as possible and thus increase the productive activities of entomologists.

The discontinuance of the Transactions of the Kansas Academy of Science has been followed by the appearance of the Journal of the Kansas Entomological Society, a serial very properly stressing matters of local interest, such as annotated lists or additions to lists, descriptions of new species, of insect collecting grounds, the history of entomology in Kansas, biological notes, and the proceedings of the sponsoring organization. The first issue, January 1928, contains a list of the literature of Kansas Arthropods, a letter from a pioneer Kansas entomologist and the proceedings of the Kansas Entomological Society. It is our judgment that there are enough progressive entomologists in Kansas to make the undertaking successful and there is certainly enough matter available to justify an avenue of publication. May the lusty child develop to the full American statue and take its place among the group of journals devoted to the dissemination of knowledge among men.

Obituaries

TERRY SPINKS ROSS

Terry Spinks Ross, a member of the American Association of Economic Entomologists, died February 5, 1928, at Meridian, Miss. Mr. Ross was suffering from Bright's disease, the immediate cause of his death being heart failure.

He was born at DeKalb, Miss., May 16, 1903, and was graduated from Mississippi A. & M. College in May, 1926, where he specialized in entomology. He had been employed in the U. S. Bureau of Entomology on boll weevil control work, at Tallulah, La. In the fall of 1926 he came to Cuba and was associated with the writer at Central Jaronú in the work on the sugar cane moth borer, under the Tropical Plant Research Foundation.

Mr. Ross was a diligent and conscientious worker. At Central Jaronú he became particularly interested in the artificial breeding of the Cuban tachinid fly parasite of the sugar cane moth borer. Mr. Ross was a man of exemplary habits, and those who had the good fortune of being associated with him will remember him as a student, a fine companion and a gentleman.—H. K. Plank.

CHARLES WALTER HOWARD

Charles Walter Howard, long a member of the American Association of Economic Entomologists died at Wheaton, Illinois, on March 1st from injuries received when he was struck by an interurban train.

Professor Howard was an entomologist of wide experience. Graduating from Cornell in 1904, he went to the Transvaal in 1905 as Assistant Entomologist and on the death of C. B. Simpson, in 1906, was appointed Entomologist. In 1908 he was made Chief of the Entomological Section of the Department of Agriculture of Mocambique, Portuguese East Africa.

Returning to this country in 1911 he became a special assistant in the Rockefeller Institute for Medical Research, engaged in the search for insect vectors of poliomyelitis. In 1912 he was appointed to the entomological staff of the University of Minnesota but in 1917 resigned his associate professorship to become Professor of Biology and soon Head of the Department in the Canton Christian College (Lingnan University).

In China his attention was quickly attracted to the needs of the silk industry in the Canton region and with remarkable success he began to apply the Pasteur methods to the control of the diseases which were rapidly wiping out silk growing in that section. Entering upon the work with an utter unselfishness and self-effacement, he won the confidence of the Chinese themselves and in 1923 he became Director of the Government Bureau for the Improvement of Sericulture of the Kwongtung Province, a position which he held at the time of his death.

In September, last, he returned to this country as Head of the Department of Zoology of Wheaton College, with the agreement that he was to return to Canton for the summer vacation and keep in close touch with the Bureau.

He was a fellow of the Entomological Society of London, a member of the American Association for the Advancement of Science, the Entomological Society of America, the South African Association for the Advancement of Science, the Royal Society of South Africa and other scientific societies. He was a member of the Pan African Trypanosomyias Commission and of the First International Congress of Entomology, held in Brussels in 1909. He was to have been chairman of the sericultural section of the Fifth Congress, meeting in August of this year in Ithaca.

To Professor Howard science offered first of all a field for service. Wherever he worked his interest in the human element was paramount. The result was that as a teacher and administrator he had the love and loyalty of his students and his associates. But, withal, he had a very genuine ability for research of a high order and in spite of his manifold duties in public service he had published numerous papers dealing with ticks, tsetse flies, mosquitoes and other blood-sucking arthropods. His studies on the chiggers of Minnesota constituted the first detailed work on these forms in this country.

He leaves a wife and four children, who are making their home at Wheaton, Illinois. For the present Mrs. Howard, whose work on the light organs of *Photinus* (as Anne B. Townsend) is well known to entomologists, is continuing his class work in Wheaton College.—WM. A. RILEY.

Review

Entomologie D'Haiti, By GEORGE N. WOLCOTT, Published by "Service Technique" of the Department of Agriculture, Port-au-Prince, Haiti. 1927.

With the publication of his "Insectae Portoricensis" and his "Entomologia Economica Puertoriqueña" Dr. Wolcott had several years ago entitled himself to the gratitude of all those interested in the entomology of the West Indies. With the appearance of the present volume under review, an exceedingly important addition has been made to this subject. It is particularly satisfactory to have such a comprehensive work covering the entomology of a country like Haiti, which heretofore has been almost unknown entomologically. Dr. Wolcott has prepared the work in connection with his teaching in the Agricultural School of *Service Technique* and for a text book of entomology in tropical America it appears to the writer that this volume may serve as a model.

The book is divided into four parts: Part one discusses the general economic relations, anatomy, physiology, and development of insects and consists of five chapters. Part two, consisting of seven chapters, is an exceedingly complete, though necessarily popular, discussion of their ecology. Part three consists of eighteen chapters, the first being devoted to nomenclature and classification and the remaining seventeen each to one order of insects. Part four consists of twelve chapters, the first of which is devoted to the general introduction on the relation of insects to the farmer and the remaining eleven are devoted to the particular insects which attack distinct crops or animals. These are divided as follows: sugar cane, coffee, cotton, tobacco, fruits, grain and legumes, stored products, domestic articles, fowl, live stock and man.

The book is very well illustrated, a great many of the drawings being original. It consists of 440 pages, is well indexed and substantially bound in cloth. Dr. Wolcott is to be congratulated on the completion of this very excellent treatise.

ARTHUR H. ROSENFELD

Current Notes

The State Legislature of New Jersey in 1927 appropriated $2000 for equipping laboratories in the Entomology Building.

Dr. J. M. Aldrich, who was ill with appendicitis for several weeks, returned to his office on January 31.

The removal of the research divisions of the Japanese beetle project from Riverton to Moorestown, N. J., is about completed.

Mr. J. C. Hamlin of the Bureau of Entomology is completing his requirements for a doctorate at the Ohio State University, Columbus, Ohio.

Dr. W. A. Hoffman, of the School of Tropical Research in Porto Rico, visited the dipterists in the U. S. National Museum on January 3.

Mr. C. H. Curran, of the Canadian Entomological Branch, studied types of muscoid flies in the U. S. National Museum collection from January 1 to 9.

Dr. B. A. Porter, Vincennes, Indiana, visited the Japanese Beetle Laboratory in December and discussed plans for future work in connection with investigations of the codling moth.

By request, Dr. R. T. Cotton, of the Bureau of Entomology, was present as an official observer at the fumigation of a large candy establishment in Chattanooga, Tenn., January 20 to 22.

Dr. E. D. Ball, former Director of Scientific Work of the Department of Agriculture, and now located in Sanford, Florida, recently spent several days in the Division of Insects, U. S. National Museum, studying Homoptera.

Messrs. A. O. Larson and C. K. Fisher, of Stored Product Insect Investigations, Bureau of Entomology, moved the headquarters for the bean weevil investigations from Alhambra to 1218 I Street, Modesto, Calif., on January 25.

Dr. Robert Matheson of Cornell University visited the Bureau of Entomology on January 5 for conference on the program of the International Congress of Entomology to be held at Ithaca, N. Y., next summer.

Mr. M. C. Swingle was granted leave of absence to take a special course in chemistry during the winter quarter at Ohio State University. He returned to the Japanese Beetle Laboratory early in March.

Mr. L. W. Brannon, Columbus, Ohio, attended the meeting of the North Carolina County and Home Demonstration Agents at Raleigh, N. C., the week of December 12, where he gave a talk on the Mexican bean beetle.

Mr. Troy Thompson, Junior Entomologist in the Division of Truck Crop Insect Investigtions, with headquarters at Biloxi, Mississippi, resigned his position during the fall to accept an appointment with the State Department of Agriculture in Alabama.

Mr. C. E. Petch of Hemmingford, Quebec, attended the annual meeting of the New York State Horticultural Society at Rochester, N. Y., January 10 to 14, and the winter meeting of the Quebec Pomological Society at MacDonald College, January 17 to 19.

Dr. F. A. Fenton, of the El Paso, Texas, field laboratory, visited Tallulah, La., about the middle of December and again the latter part of January, to confer regarding the pink bollworm and other cotton-insect problems.

Mr. W. A. Ross, of the Vineland Laboratory, attended the annual meeting of the New York State Horticultural Society in Rochester on January 11 and 12, and a conference on the Oriental peach moth at Harrisburg, Pa., on January 17.

Dr. J. W. Folsom, of the Cotton Insects Field Laboratory at Tallulah, La., was a visitor in the Division of Insects, U. S. National Museum, on January 27, and left for identification many lots of insects collected by airplane.

Dr. L. O. Howard has called attention to an error in the editorial of the December issue. It is there stated, following the official announcement, that he is "the only American honorary member of the Academy of Agriculture of France," whereas it should have been, that he is the only American full member, this being the case since the death of Prof. C. S. Sargent of the Arnold Arboretum.

Mr. Ralph Hopping, Entomological Branch, Ottawa, Canada, attended the annual meeting of the Canadian Forest Engineers held at Quebec, January 22 to 24, and presented a paper prepared by Dr. J. M. Swaine, entitled "Progress in Forest Insect Control in Canada."

Mr. J. M. Miller of the Forest Insect Investigations, Bureau of Entomology, visited the Prescott National Forest in Arizona, the third week of January, to inspect the control operations against *Dendroctonus barberi* Hopk., which have been in progress there during the winter.

Mr. J. R. Sim, of the Japanese Beetle Laboratory, Moorestown, N. J., spent nearly a week in the latter part of January making drawings of the genitalia of species of Phyllophaga in the Coleoptera collections of the U. S. National Museum.

Mr. S. S. Crossman, of the Gipsy Moth Parasite Laboratory, Melrose Highlands, Mass., visited Washington in December to confer with Bureau officials and assist in the arrangement of three new motion-picture reels of the gipsy and brown-tail moths.

Mr. E. R. DeOng, formerly Assistant Entomologist in Charge of the insecticide laboratory, University of California, has opened an office and laboratories as consulting entomologist in the chemistry of insecticides. in the First National Bank Building, Shattuck, at Center Street, Berkeley, Calif.

Mr. Curtis P. Clausen, of the Bureau of Entomology, who has been in charge of the foreign phases of the parasite work on the Japanese beetle, recently returned from India, where he has been collecting and rearing parasites during the past three years.

Dr. E. P. Felt, after serving the State of New York for nearly thirty-three years, first as assistant, and for nearly thirty years as State Entomologist, has retired on pension effective March 31 and will be Chief Entomologist of the Bartlett Research Laboratories, Stamford, Conn.

Mr. Harry Steiner, recently associated with D. B. Mackie, has severed his connection with the California State Department of Agriculture and will go to Turkey, where he will be engaged in the fumigation of figs, in the interest of the National Biscuit Company.

Mr. F. E. Wilson, a graduate student at Harvard University, visited the Division of Insects, U.S. National Museum, in the early part of January, to discuss taxonomic work on the genus Scymnus. Mr. Wilson is planning work on a taxonomic revision of Scymnus of North America.

According to *Science*, Professor R. A. Cooley, Professor of Zoology at Montana Agricultural College, has planned to leave April 1 on a year's leave of absence and will spend part of the time in the interior of Africa with the Chicago Zoological expedition in studying tick parasites.

An institute for tree workers was held on February 29 at the Yale School of Forestry, New Haven, Conn., by the Tree Protection Examining Board of Connecticut. Brief addresses were given by the following entomlogists: Dr. E. P. Felt, Mr. A. F. Burgess, Prof. A. I. Bourne, Mr. Neely Turner and Dr. W. E. Britton.

Mr. R. T. Webber will remain at the Gipsy Moth Laboratory during the present season to continue certain biological and systematic studies relating to the parasitic Diptera. In the preceding five years he has made five trips to Europe and Africa, each of about six months' duration, for the collection of parasites.

The Fourth Shade Tree Conference was held at Washington, D. C., March 22 and 23. Dr. E. P. Felt was Chairman, and Drs. C. L. Marlatt, W. E. Britton, and Mr. William Middleton took part in the program. Other entomologists present for at least a portion of the time were A. F. Burgess, Dr. S. B. Fracker, W. O. Hollister, J. S. Houser, J. A. Hyslop, and Dr. C. H. Richardson.

Dr. H. C. Huckett, of the Long Island Vegetable Research Farm of the Agricultural Experiment Station, Geneva, N. Y., visited at Branch headquarters, Ottawa, Canada, for several weeks in January studying the Anthomyidae in the National Collection. The Branch collection of Anthomyidae is one of the largest and best on the American continent.

Dr. George N. Wolcott (Cornell '09, Ph.D. '25), who was formerly entomologist at the Insular Experiment Station at Rio Piedras, Porto Rico, and more recently has been with Service Technique, Port-au-Prince, Haiti, has accepted a position with the sugar-cane and cotton Experiment Station at Lima, Peru, of which Dr. C. H. T. Townsend is Director.

Mr. R. E. McDonald, Entomologist of the Texas Department of Agriculture, Austin, visited Washington January 27 to 30. Although his principal interests were concerned with the Federal Horticultural Board's discussions of the pink bollworm, he found time to visit the Division of Truck-Crop Insect Investigations and discuss the problem of the sweet potato weevil in Texas

On invitation of H. C. Cole, Secretary, Dr. E. A. Back, of the Bureau of Entomology, attended the convention of the Insecticide and Disinfectant Manufacturers Association, held in the Hotel Astor, New York City, on December 14. Of special interest to entomologists was a motion picture exhibited by the Chemical Warfare Service depicting the warfare against insects.

Mr. J. A. Beal, Forest Insect Investigations, Bureau of Entomology, was in the field a considerable part of January making studies of the effect of a sudden drop in temperature in the latter part of December on broods of the Southern pine beetle. He states that everywhere there seems to be very high mortality of all stages except the egg.

Mr. A. Kelsall of Annapolis Royal, N. S., attended the meeting of the Massachusetts Fruit Growers Association at Worcester, Mass., on January 4 to 6, and gave addresses on the apple maggot and the apple situation in Nova Scotia. On January 13, Mr. Kelsall also addressed the Nictaux Community Club, Nictaux, N. S., on certain serious pests of apple. He was recently elected mayor of Annapolis Royal by acclamation.

It has been decided to carry out airplane dusting experiments against the spruce budworm in northern Ontario, during the coming summer, instead of in Cape Breton Island. It is anticipated that the spruce budworm outbreak in Cape Breton Island will be much less severe in 1928. It is also planned to carry out airplane dusting experiments in the control of the hemlock looper in the Muskoka district, Ontario, during the coming season.

Dr. H. W. Allen and Mr. H. A Jaynes, of the Japanese Beetle Laboratory at Moorestown, N. J., visited the U. S. National Museum on January 30 and 31 for the purpose of conferring with Mr. Gahan regarding the identity of a number of parasitic wasps which are being introduced from the Orient to combat the Japanese beetle. While he was in Europe, Mr. Gahan compared specimens with types of Oriental Tiphia in the British Museum and made notes for the use of Dr. Allen and Mr. Jaynes.

Mr. O. I. Snapp, in charge of the Peach Insect Laboratory of the United States Bureau of Entomology, Fort Valley, Georgia, visited the Entomology Department of the Mississippi A. & M. College on February 4. While there he addressed a group of entomological workers connected with the College, State Plant Board and Experiment Station, as well as a number of students especially interested in entomology. He discussed especially the work with peach insects that has been done at the Fort Valley station during the past year or two.

Mr. Andrew Fleming of Natchez, Miss., died on December 16, 1927. Mr. Fleming was a cotton planter who had for many years been much interested in various phases of entomology and had been of much assistance to the entomological workers in Mississippi. Although he probably never published anything in regard to insects, he was well acquainted with the insects of his region, and especially with the life histories, habits, and distribution of the mosquitoes in the vicinity of Natchez, Miss. He was a member of the Entomological Society of America.

Beginning May 14th and continuing until June 24, 1928, E. O. Essig will conduct a University of California course in field entomology in the Yosemite National Park, with headquarters at the new Yosemite Park Museum. From July 1st to August 1st of the same season he will be at his permanent summer camp at Echo Lake, 7,500 feet altitude, eleven miles from Lake Tahoe. Entomologists visiting California, are cordially invited to call on Professor Essig at either of the above places and he will be very glad to assist them in the various types of entomological work in those regions.

During the winter months, three shipments of parasites were received at the Moorestown laboratory. All of these were Tiphia wasps in the cocoon stage, reared from ovipositions obtained on Popillia grubs at the different field laboratories. From Shillong, India, 9,000 cocoons of Tiphia No. 2036, a large percentage of which were affected by fungus, were received in November. From Miho, Japan, 5,000 cocoons of Tiphia No. 1851, in very good condition, and 700 cocoons of Tiphia No. 5, from Suigen, Korea, which were largely attacked by fungus, arrived in December. From Pennin, China, 9,000 cocoons of Tiphia No. 115 arrived in January in very good condition.

Mr. A. B. Gahan returned to Washington on January 16 after four months spent in Europe studying in the various museums. The purpose of the visit was to study types of Chalcidoidea in a number of the old collections of Europe, notably the Förster, Gustav Mayr, Ratzeburg, Walker, and Westwood collections. The greater part of Mr. Gahan's time was spent in the British Museum of Natural History, but he also visited the Hope Museum at Oxford, the Musée National d'Histoire Naturelle at Paris, the Naturhistorisches Museum at Vienna, the Forstliche Hochschule at Eberswalde, the Deutsches Entomologisches Institut at Dahlem, and the Zoologisches Museum der Universität at Berlin. Many interesting notes and a large number of specimens which have been compared with types were secured.

Southern entomologists were given notable recognition at the meeting of the Association of Southern Agricultural Workers held at Memphis, Tenn., on February

1, 2, and 3. This Association consists of several hundred workers in all the various branches of agriculture, including agronomy, horticulture, agricultural engineering, agricultural economics, animal husbandry, etc. Dr. H. A. Morgan, President of the University of Tennessee, was elected President, Dr. Wilmon Newell, Director of the Agricultural Experiment Station, Director of the Agricultural Extension Service, Dean of the College of Agriculture, and State Plant Commissioner of Florida, was elected First Vice-President, and Dr. W. E. Hinds, Entomologist of the Louisiana State University was elected Second Vice-President, During 1927 Dr. Morgan had served as First Vice-President, Dr. Newell as Second Vice-President, and Dr. Hinds as Secretary of the Southern Association of Agricultural Workers. These three men are active members of the American Association of Economic Entomologists, and have long been recognized as entomological leaders in the Southern States.

Apicultural Notes

At the meeting of the Maryland State Beekeepers' Association on January 4, the following papers of interest to technical workers were presented: "The Improvement of Races of Bees," by W. W. Alpatov, and "Chroma-Vision in the Honeybee," by L. M. Bertholf.

An announcement was made at the recent convention of the American Honey Producers' League held at San Francisco, January 24 to 27, of the election of Mr. E. L. Sechrist, of the Bee Culture Laboratory of the Bureau of Entomology, as Secretary-Treasurer for the ensuing year. Mr. Sechrist, however, declined the position because of pressure of official work.

Mr. James I. Hambleton, of the Bee Culture Laboratory of the Bureau of Entomology, attended the meeting of the Oklahoma State Beekeepers' Association, at Oklahoma City, on January 16 and 17, the meeting of the Arkansas State Beekeepers' Association, held at Little Rock on January 18 and 19, and a conference of delegates representing beekeeping interests in Texas, Louisiana, Arkansas, and Oklahoma, held at Texarkana, Ark., on January 20 and 21.

Among recent visitors at the Bee Culture Laboratory of the Bureau of Entomology were Mr. Frank C. Pellett, Associate Editor of the American Bee Journal; Dr. W. W. Alpatov, of the University of Moscow, Russia; Dr. Ragnar Frisch, of the University of Oslo, Norway; Mr. P. E. Crane, of the firm of J. E. Crane and Son, Middlebury, Vt.; and Prof. L. E. Dills, Instructor in Beekeeping at the University of West Virginia. Doctor Alpatov, who is in this country under a Rockefeller fellowship, is continuing his work on variation in the honeybee at Johns Hopkins University with Doctor Pearl. Doctor Frisch is also in this country under a Rockefeller fellowship.

Notes on Horticultural Inspection

Mr. J. F. Adams, Plant Pathologist of the Delaware State Board of Agriculture, has been placed in charge of nursery inspection in that state.

Dr. C. L. Marlatt spent about two weeks in Texas early in March studying the pink bollworm situation and visiting the Mexican fruit worm eradication area.

The Federal white pine blister rust quarantine was amended, effective March 1, adding all of Idaho and four new counties of Oregon to the area designated as infested.

Mr. Joseph T. Watt, a graduate of Alabama Polytechnic Institute, was appointed Junior Plant Quarantine Inspector on February 1 and assigned to port inspection work at Eagle Pass, Texas.

Mr. G. R. Williams, for several years an inspector for the State Plant Board of Mississippi, with headquarters at Durant, resigned recently. He is now pastor of the Methodist Church at Lamar, Miss.

Messrs. Madimore Brunson and K. B. McKinney were transferred from the Federal Horticultural Board to the Truck Crop Insects Division of the Bureau of Entomology on March 16 and February 16, respectively.

Mr. C. H. Rothe, who has been engaged in port inspection work at Eagle Pass, Texas, for some time, was transferred on February 18 to the Date Scale Eradication force of the Federal Horticultural Board at Indio, Calif.

Mr. G. R. Fulton resigned his position as inspector for the State Plant Board of Mississippi, with headquarters at Grenada, on December 31, in order to accept a position as county agent for Grenada County. His address is Grenada, Miss.

Mr. J. H. Painter resigned as a junior plant quarantine inspector at New York on January 31 to become research horticulturist at Goodwell, Okla. He was succeeded at New York by Mr. O. G. Fitzgerald, a graduate of Louisiana State University.

A joint resolution passed Congress and was approved March 7, making an additional amount of $200,000 immediately available to the U. S. Department of Agriculture to cope with the new outbreak of the pink bollworm in western Texas.

Mr. N. L. Douglass, a graduate of the Mississippi A. & M. College in the class of 1926, has been appointed inspector for the State Plant Board, with headquarters at Grenada. He has charge of the Plant Board work in Carroll, Grenada, Montgomery, Tallahatchie, and Yalobusha Counties

Mr. C. E. Cooley has been transferred from San Juan, P. R., where he has been in charge of port inspection for the Federal Horticultural Board, to Washington, D. C., to take charge of the special permit section in the Import Division of the Board. He was succeeded in Porto Rico by Mr. C. P. Trotter.

Mr. H. C. Hallock, an associate entomologist on the Japanese beetle staff, reports that a number of beetles collected at trap lights on Long Island in 1927 have recently been identified as *Serica similis*, an insect infesting sugar beets and other crops in Japan.

The following definition of "nursery stock" was adopted by the Central Plant Board on March 3: "The term 'nursery stock' shall be considered to include all woody and herbaceous biennial or perennial plants, and parts thereof except the seeds, for or capable of propagation, or capable of carrying injurious pests."

Mr. D. W. Grimes has recently been reappointed as an inspector for the State Plant Board of Mississippi, with headquarters at Durant, Miss. He has charge of the Plant Board work in the Counties of Attala, Holmes, Leake, and Leflore. Mr.

Grimes resigned a position with the Mississippi Plant Board about two years ago and recently has been engaged in the Mexican fruit fly work in South Texas.

Recent changes in the pink bollworm and Thurberia weevil field service include the appointment of J. H. Adams, a graduate of the Mississippi A. & M. College, W. C. Maxwell, a graduate of Clemson College, and K. A. Gallant, as junior plant quarantine inspectors; the transfer of M. H. Ford to the Mexican fruit worm staff, and of C. P. Daley to the Mexican Border inspection service at Brownsville; also the resignation of M. E. Cole to enter commercial work.

The Texas State Pink Bollworm Commission on March 7 recommended to the Governor of Texas the designation of Brewster County as a noncotton zone, the extension of the regulated zone to include Ector, Martin, Midland, Glasscock, Howard and Andrews Counties, "and such other adjacent areas as may be contaminated," and the creation of a joint high commission composed of representatives of our National Government and the Government of Mexico, "for the purpose of providing ways and means for the eradication of the pink bollworm from the whole of North America."

On February 4, a consignment of five hundred cases of bitter oranges from Messina, Sicily, for I. T. shipment to Canada, was inspected in New York and found to be heavily infested with the Mediterraean fruit fly. Not only were maggots found in the fruit, but puparia and adults were noted in abundance. Owing to the temperature which prevailed in New York at that period, the adults were very sluggish and their wings did not become fully spread. Following the transfer of the fruit in question to a vessel bound for Canada, the hold which had contained the infested fruit was thoroughly cleaned and fumigated under the supervis on of inspectors of the Federal Horticultural Board.

The Central Plant Board met at St. Louis, Mo., March 2 and 3. Nine of the thirteen States were represented. Representatives of the American Association of Nurserymen and the State Nurserymen's Association of Illinois, Missouri, and Ohio were present by invitation, as was also Prof. A. J. Riker, Madison, Wis., representing the Crown Gall Committee of the Crop Protection Institute. The Board took exceptions to the provisions of Federal Quarantine No. 62, which requires states to require inspection and certification of narcissus for intrastate movement as a condition of certifying narcissus for interstate movement. The Board by an 8 to 1 vote recorded itself opposed to granting to the Ralston Purina Mills the privilege of shipping alfalfa hay from the alfalfa weevil infested areas of the West to its mills in Kansas City, Mo., for milling purposes. The report of the Committee on Uniform Raspberry Regulations was adopted. It provides for two inspections, not more than an 8% infestation of raspberry plantations with mosaic at the time of the first inspection, and not more than a 2% infestation at the time of the second inspection, as a condition of certifying raspberry plants. The Board also adopted the report of the Committee on Uniform Requirements for Interstate Movement of Nursery Stock in the Central States. The following officers were elected: President, Frank N. Wallace; Secretary-Treasurer, P. A. Glenn; Member National Plant Board for the unexpired term of S. B. Fracker, two years, A. G. Ruggles; Member National Plant Board, three years, George A. Dean.

The Eastern Plant Board met in the American Museum, New York, on January 28. The following subjects were considered: The chestnut blight, the New England corn borer situation, white pine blister rust, mild mosaic on raspberries, the Japanese beetle, the gipsy moth in the Barrier Zone, potato certification and the progress report on the "Black List" of nursery pests. During the afternoon session, Messrs. C. H. Perkins, Lester C. Lovett, William Flemer, Jr., and Robert Pyle, representing the Eastern Nurserymen's Association and American Nurserymen's Association, were invited to be present for a joint discussion of the many problems facing both nurserymen and regulatory officers in the interstate movement of nursery stock. All the officers were re-elected as follows: President, T. J. Headlee; Secretary, Ernest N. Cory; Representatives National Board of Review: W. C. O'Kane, W. A. McCubbin; Executive Committee: C. H. Hadley, A. W. Gilbert, W. E. Britton. In addition to the officers, the following men were in attendance: C. H. Zimmer, H. L. McIntyre, and B. D. Van Buren, Albany, New York., C. H. Perkins, Newark, N. Y.. Harry B. Weiss and William H. Martin, New Brunswick, N. J., C. W. Stockwell, Riverton N. J., Lester C. Lovett, Little Silver, N. J., William Flemer, Jr., Princeton, N. J , G T. French, Richmond, Va., W. E. Rumsey, Charleston, W. Va., Harold L. Bailey, Bradford, Vt., R. Harold Allen, Boston, Mass., Robert Pyle, West Grove, Pa., J. F. Adams and W. L. Mifflen, Dover, Del.

Notes on Medical Entomology

Professor George A. Dean of the Kansas Agricultural College, conferred with Mr. F. C. Bishopp of the Bureau of Entomology on January 5, regarding certain work on external parasites of livestock which is under way at the Kansas institution.

The fifteenth annual meeting of the New Jersey Mosquito Extermination Association was held at Atlantic City, February 15 to 17. Papers were read by the following entomologists: Dr. L. O. Howard, Mr. Arthur Gibson, Dr. Robert Matheson, Dr. T. J. Headlee, and Dr. W. E. Britton.

Mr. F. C. Bishopp of the Bureau of Entomology, and Prof. L. I. Case of the Virginia Polytechnic Institute, visited Burkes Garden, Va., on January 13 to arrange for the season's cooperative work on control of the cattle grub, which is under way in Burkes Garden.

Mr. E. W. Laake, of the Dallas, Texas, field laboratory of the Bureau of Entomology, delivered two addresses on January 10 and 11 to the farmers attending the special Livestock Short Course held at College Station, Texas. The screw worm and its control, and the cattle grub as a source of loss to livestock raisers, were the two principal problems discussed.

Erratum

On page 129, line 7 from bottom of the February Journal, read As_2O_3 for As_3O_3.

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Proceedings of the Fortieth Annual Meeting of the American Association of Economic Entomologists

Section of Plant Quarantine and Inspection

Tuesday Morning, December 27, 1927

The meeting of the Section of Plant Quarantine and Inspection, held in connection with the Fortieth Annual Meeting of the American Association of Economic Entomologists, at the Y. M. C. College, Nashville, Tennessee, convened at ten-five o'clock, Mr. J. H. Montgomery presiding.

CHAIRMAN MONTGOMERY: I have two committees to appoint. The Nominating Committee will consist of the following: Lee A. Strong, A. G. Ruggles and R. W. Leiby.

The Resolutions Committee will consist of the following: Richard Faxon, L. S. McLaine and E. L. Chambers.

Any resolutions which this Section desires to have submitted to the parent body should be handled through this committee.

The first thing on the program is an address by the Chairman.

(Published in the Quarterly Bulletin of the Florida State Plant Board.)

C. L. MARLATT: I do not want to discuss the address, but I simply want to say I have listened with a great deal of pleasure, and I am heartily in accord with all of the principles laid down. I think it is a very masterful presentation and a very useful and instructive one for all of us.

I fully appreciate, also, the point the Chairman made relative to the educational work which the state people should do with their representatives in Washington. I am not afraid to say that here or anywhere else, because, after all the Congressmen, the Senators and other representatives you may have in Washington, in the Federal Government, are citizens of your state, interested in your state and your problems, interested also in national problems. There is no reason why they should not be educated to the needs of the state and nation as well as the rest of us.

E. R. SASSCER: I quite agree with the statements made by Mr. Marlatt. I merely rise to call to your attention one of the problems which plant quarantine officials will undoubtedly have to meet in the future. Just recently I had a communication from the Bureau's representative in charge of the work in Porto Rico, furnishing me with a schedule of the airplane travel between Haiti and Porto Rico. There are some three planes flying between Haiti and Porto Rico weekly. Fortunately, this inspector is on the job. He is working with the customs officials. Up to the present date he has been able to meet all of the airplanes upon arrival. He pointed out, however, that frequently they made a trip in about three hours, and sometimes he had difficulty in getting his men to the landing field. It seems these planes carry from eight to ten passengers, and evidently there is some baggage brought along. As yet he has not detected any fruits or vegetables which would be prohibited.

CHAIRMAN MONTGOMERY: We will now receive reports from the various regional boards. Is Mr. Headlee here? In his absence is there anyone here who can submit a report on the activities of the Eastern Plant Board? (No response).

Mr. Haseman, Will you submit a report from the Central Plant Board, please?

CENTRAL PLANT BOARD

The Central Plant Board held its annual meeting March 4 and 5, 1927 at Madison, Wisconsin with official representatives from Illinois, Indiana, Kansas, Michigan, Minnesota, Missouri and Wisconsin. In the absence of President Ruggles, the writer was elected acting president.

Dr. Fracker presented the report of our representatives on the National Plant Board. This report including a number of recommendations was received and held over for later action. At a later session our Board voted to delay action on the question of assessing fees for establishing a fund for the National Plant Board. It approved the resolution concerning the discontinuing of license fees and bonds required of nurserymen. It approved the National Plant Board's suggestions (1) relative to inspecting nursery stock and attachment of certificate tags; (2) date certificates are to expire; (3) fumigation to be an auxiliary and not a substitute for inspection; (4) inspection of grounds surrounding the nursery; (5) states issuing quarantines to report same to Federal Horticultural Board and to other states interested. It voted to change its name to the Central Plant Board. Our Board adopted a report of a special committee appointed the previous year to draw up recommendations on certification of greenhouse plants and hardy outdoor perennials after the same had been amended at various points. The details of this are on file. Our Board took no action on the suggestion regarding moving forward to 1927 the conference on rose and fruit stocks announced by the Federal Horticultural Board for 1928. Our Board took further action as follows:

1. Because of the frequent arrival of uncertified shipments of nursery stock from California it was the sense of the members present that such shipments should be returned to the shipper.

2. It was the concensus of opinion that the Supreme Court decision of April 1925 rendered it necessary to reenact only quarantine laws passed subsequent to August 20, 1912 and prior to April 12, 1926, and that states apparently are without authority to prescribe under what conditions nursery stock may be brought into the States.

3. It was the sense of the meeting that corn borer quarantine lines should be completely waived before movement of sweet corn begins in any part of the quarantined area.

4. Recommended to Federal Horticultural Board that corn on the car be prohibited from moving from heavily to lightly infested areas.

5. Recommended to the Federal Horticultural Board either of the following amendments to quarantine No. 63 whichever is more satisfactory.

a. That uninfected areas be recognized in Minnesota, Wisconsin and Michigan, the same to be separated from infected areas by a safety zone of from 25 to 50 miles and that dormancy, defoliation and dipping in lime sulphur be required in the safety zone and that interstate shipments from uninfected areas be restricted to red, white and Alpine currants and to cultivated gooseberries.

b. In place of requiring the absence of *Ribes nigrum* within one mile of all nurseries receiving permits, a certificate from the state inspector showing that no white pine blister rust has been found nearer than 25 miles within the last 8 years.

6. Resolution passed urging South Dakota Department of Agriculture to establish and enforce a quarantine against known alfalfa weevil infested areas.

7. It was the sense of the meeting that all quarantines should be put on sheets of uniform size to facilitate filing; if mimeographed the regular 8½ x 11 be used; if printed the uniform circular 6 x 9 be used.

In informal discussions our members opposed the suggestion of the western Plant Quarantine Board, that inspection of all nursery stock be made at destination and that certificate tags on shipments be dispensed with.

It was thought that new laws with authority to stop vehicles for inspection might aid in controlling vehicular traffic if such provisions were not declared unconstitutional.

Next meeting of our Board will be held March 1, 2 and 3 in St. Louis, Missouri.

L. HASEMAN, *President, Central Plant Board*

CHAIRMAN MONTGOMERY: The next regional board report will be that of the Southern, Professor Harned.

REPORT OF THE SOUTHERN PLANT BOARD

The Southern Plant Quarantine Board was organized at Atlanta, Georgia, on February 3 to 5, 1926, when twenty of the plant quarantine officials of ten Southern States and Lee Strong of California met at the time of the annual meeting of the Southern Agricultural Workers' Association. The states represented were North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, Tennessee, and Arkansas. Oklahoma was the only state in this region not represented.

The minutes of this meeting, as well as a copy of the Constitution and By-Laws, are published in the Quarterly Bulletin of the State Plant Board of Mississippi for April, 1926. This bulletin is available for anyone who may care to obtain it.

The second meeting of the Southern Plant Quarantine Board was held in Atlanta, Georgia, on February 1, 1927. The twenty-five people in attendance represented nine of the eleven states in this region. Arkansas and Oklahoma were the only states not represented.

Dr. Wilmon Newell, Representative on the National Plant Board, discussed fully the work of the National Board, and gave a report of the proceedings of the meeting held in Washington in June 1926. In accordance with a recommendation from the National Board, the Southern Plant Quarantine Board voted to change its name to the Southern Plant Board.

The same officers that had served during 1926 were re-elected for 1927, except that R. E. McDonald of Texas was elected for a two-year period as Representative on the National Plant Board to take the place of George G. Becker of Arkansas who had resigned his position in that state to accept a place with the Federal Horticultural Board.

Although the Southern Plant Board has been in existence for only two years, an informal organization of the quarantine officers and entomologists in this region has been meeting quite frequently for more than twenty years.

R. W. HARNED

CHAIRMAN MONTGOMERY: Mr. Strong will you submit a report from the Western Board?

REPORT OF THE WESTERN PLANT QUARANTINE BOARD

The ninth annual Western Plant Quarantine Board meeting at Reno, Nevada, June 20–21, 1927, was one of the most representative meetings in point of attendance of any held for several years past. There were members from Arizona, California, Colorado, Idaho, Nevada, New Mexico, Oregon, Utah, Washington, British Columbia, Hawaii and Lower California, representing twelve of the fourteen states, districts, provinces and territories comprising the Board. In addition, Professor R. W. Harned of Mississippi, President of the American Association of Economic Entomologists, was in attendance and two representatives from the Department of Agriculture and Development of Mexico. The Western Plant Quarantine Transportation Committee had three representatives; namely, the American Railway Express, Southern Pacific and Union Pacific.

Chairman Oscar C. Bartlett, Arizona, in his address, noted first, that the Western Plant Quarantine Board session should extend over a period of time adequate to clear up many of the problems delegated to committees because of the difficulty of committee members getting together between sessions to discuss problems referred to them. Delays and inability to reach definite conclusions until the Board actually met again became apparent. To attempt to discuss matters delegated to them at the annual conference reacted to the disadvantage of the meeting itself. Finances presented a difficulty in bringing committee members together at times between regular board conferences. Secondly, he urged sound consideration of any and all actions on resolutions submitted by the National Plant Board. The Western Plant Quarantine Board should be in a position to give a well weighted and sound response to such matters because of its long experience. Third, he emphasized the importance of working closely with Mexico and cited the trip made into that country by some of the members of the Western Plant Quarantine Board in September, 1926, as of great mutual benefit.

G. H. Hecke, Director of Agriculture, California, dwelt upon the importance of correlating all plant quarantine work. The Mexican fruit fly situation and the quarantine features involved were stressed and he urged every energy of the Western Plant Quarantine Board to supporting conclusive action toward its elimination from the United States. He pointed out that as a result of the Supreme Court decision we had learned that there were many sides to the quarantine situation and that unsound practices in quarantine could result in nothing but disaster. The importance of the federal government calling quarantine officials together at federal expense, or calling regional groups to discuss specific problems was noted as vital. He also pointed out that an advance in membership fees should be seriously considered in order to help the conclusive work that the Western Plant Quarantine Board was doing within its own jurisdiction and to aid the National Plant Board.

The standing committee on pest surveys reported a plan for consistent reports to be given at each Western Plant Quarantine Board meeting and agreed to correlate such information as to be most advantageous to the membership. The recommendation was:

"(a) Future crop pest list reports shall be tabulated in the following manner:

1. Common name
2. Scientific name
3. Host plants
4. Major or minor pest

(b) That representatives of the Board present at the ninth annual conference who have already submitted lists shall revise the lists submitted to conform to the above recommendation.

(c) That future reports, after one complete list is in the hands of the committee and has been published, need only consist of new or especially prominent pests."

The pest treatments committee reported through D. B. Mackie, California, who outlined methods commonly in vogue in order to arrive at a basis for discussion. Hydrocyanic acid, carbon bisulphide, dips, heat and mechanical means for suppressing pests were discussed. It was contended that the policy of this committee should be to develop methods which would aid in preventing quarantine restrictions interfering with traffic in plant products. The committee was to continue seeking data as to methods in cooperation with all agencies which might have suggestions or facts based on research data available.

Under new topics, W. H. Lyne, British Columbia, suggested that nurserymen be encouraged to hire pest control experts in order to reduce the burden of nursery inspection by regulatory officials and ordinarily aid the nurseryman in his ability to ship clean products.

G. C. Schweis, Nevada, brought up the matter of year-around shipment of alfalfa meal under proper safeguards from alfalfa weevil infested districts. (Note: Resolution passed by the Board forwarded to Washington whence it was learned that the U. S. Bureau of Entomology was delegating certain specific duties with reference to this project to George I. Reeves. He is hopeful of being able to devote full time to developing data with reference to the possibility or impossibility of year-around alfalfa meal shipments from weevil areas through a member of his staff.)

LEE A. STRONG

REPORTS OF THE STATES

ARIZONA.—Dr. Oscar C. Bartlett.—General pest conditions reported upon and inspection results noted; especially mentioned pink bollworm and Thurberia weevil infestations. In the case of pink bollworm, Dr. Bartlett did not agree with the theory that commercial planting seed was responsible because most of this seed came from Coachella Valley, Calif., an area known to be free of pink bollworm. It may have been bootleg seed. Could not venture any definite opinion as to the possible outcome of injunction proceedings invoked in the Tucson area.

BRITISH COLUMBIA.—W. H. Lyne.—*Lecanium corylii* had not spread to any appreciable extent.

HAWAII.—Theo. C. Zchokke.—Reported that Mr. D. T. Fullaway, Chief Inspection Officer for Hawaii, had urged the development of more information on pests of the Pacific Ocean region. Many pests are now known from scientific records but their economic status is unknown or very fragmentarily recorded. The possibility of an organization for such purpose for the Pacific region. He cautioned against fruit flies to the extent that anything and everything that can be done to keep them out should be done regardless of how drastic. No one in Hawaii eats fruit after dark except in good light.

LOWER CALIFORNIA.—O. A. Pratt.—The governor of the district has taken over the administration of quarantine funds, which funds are derived from a cotton tax. The Camara Agricola, originally instituted to administer this work, has been left without the authority it previously had.

NEW MEXICO.—Dr. H. L. Kent.—Due to illness was unable to attend the New Mexico legislature to present legislation for re-enactment of quarantine authority, although the Board of Regents did have more extensive regulatory powers than normally allotted to the average state agency. He commented very specifically on the value of education of farmers on quarantine matters as a result of the combination of these activities within the College of Agriculture in his state.

COLORADO.—Geo. M. List.—Reported on general pest conditions.

OREGON.—Don C. Mote.—Representing Mr. Park, noted the finding of alfalfa weevil in haystacks after they were reported free of this pest.

UTAH.—Dr. F. E. Stephens.—Emphasized the importance of weed control.

WASHINGTON.—J. I. Griner.—Stressed the importance of gaining additional assistance for European earwig control regardless of whether by bait methods or by biological control. Also the difficulties being encountered in Colorado potato beetle certification of potatoes because of the attitude of ranchers.

CALIFORNIA.—W. C. Jacobsen.—Presented a general report as to pest conditions, pest spread, and particularly stressed the white fly program as an example of intensive pest control procedure. The infestations now present were outside of the main citrus producing area and only very limited as to area of spread. Other pest spread was noted.

All of the states reported on new quarantine regulations which had become effective within the year, also action taken by their legislatures in restoring basic quarantine legislation.

A paper prepared by Lee A. Strong, Chairman of the National Plant Board, was read, discussing that organization, its accomplishments and possible effect on the trend of the quarantine work in the United States. The importance of the National Plant Board was impressively brought out and its relationships to the regional boards, whereby mutual benefits could be derived, were clearly stated. A most important value of the Board seemed to lie in the direction of simplifying the complicated and unwieldy quarantine condition now existing and instilling a uniformity which will redound to the benefit of regulatory work generally. A national survey of the whole quarantine situation can be materially aided by the National Plant Board. Without full coordination in plant quarantine work there is apt to be difficulty ahead for quarantine enforcement in general.

REPUBLIC OF MEXICO.—Dr. Alfons Dampf and E. Coppel Rivas.—Plant quarantine work has received a real recognition in the Republic of Mexico as is manifested by the establishment by presidential decree of the Oficina para la Defensa Agricola (Office of Agricultural Defense) January 1, 1927. This office embodies within it a combination of the duties of Federal Horticultural Board, Bureau of Entomology, the plant disease section of the Bureau of Plant Industry and the pest publication and statistical work found in the United States Department of Agriculture. These men credited the contacts with the Western Plant Quarantine Board and the trip made through Mexico last year by members of the Western Plant Quarantine Board as giving a great impetus to the new start which they had. They have placed the inspection work in the hands of technically trained men and have constructed vacuum fumigation equipment at Guadalajara, part of which was already in operation in June, 1927.

Dr. A. W. Morrill, Dr. O. C. Bartlett and Mr. O. A. Pratt particularly mentioned the need for more Federal Horticultural Board men to do inspection work on the international boundary. Reports indicated that the personnel was not adequate, at least at Nogales, to have inspectors on the job during the entire time when inspections should be made. Dr. Morrill noted having returned from Mexico on the Southern Pacific line on the early morning train through Nogales without inspection being made of his baggage by Federal Horticultural Board men. The reaction of these men who had been in contact with the inspection work through Nogales indicated that it should be considerably more intensive.

THE WESTERN PLANT QUARANTINE BOARD TRANSPORTATION COMMITTEE.—E. E. McMichael, Chairman,—American Railway Express.—This committee continues to offer every assistance in aiding to prevent introduction of injurious insect and disease pests and wants whatever suggestions can be given. A difficulty in connection with transportation was presented by Dr. F. E. Stephens of Utah. The incident specifically mentioned was as follows: A carload of nursery stock starts from an area Utah has under quarantine, moves into another state not maintaining a quarantine against the area of origin. Part of the car is unloaded and the unloaded material replaced with new material at the first destination, which area is not under quarantine by Utah. Therefore, a car billed from the first destination reaches destination in Utah apparently from an unquarantined area, yet a portion of the consignment actually originated in dangerous territory.

BORDER INSPECTION DISCUSSION.—A. C. Fleury, California.—Outlined border station experiences in California. Nearly 9,000 lots of plant products, either contraband, actually infested or refusable because of violation of a quarantine order or regulation, were intercepted. This was contrasted with the interior inspection carried on by the state quarantine guardians where only 1,109 lots were intercepted.

There were 35 men on the job at border stations and approximately 250 men at the interior points. This is not in any sense a reflection on the inefficiency of interior inspection but decidedly points out the importance of border inspection.

During 1925, 3046 alfalfa weevil were taken from 509 automobiles; during 1926, 1,800 live alfalfa weevil were taken from 331 automobiles. It has been shown that weevils are not necessarily picked up in alfalfa fields but very often in rubbish and grass about auto camps located in the general vicinity of alfalfa fields.

The following statement was made in connection with one day's inspection (Feb. 9, 1927) at a southern border station.

"Of 181 autos inspected, 31 carried plant material in violation of the California quarantines. Some of these were:

6 apples from Connecticut
1 Arizona cotton picking bag
1 lot of Mexico sapotes via El Paso (Hosts of Mexican fruit fly)
4 Arizona navel oranges
1 New Mexico orange in a suitcase
2 Florida grapefruit
2 Florida grapefruit
2 pounds Florida sweet potatoes
2 Texas apples
1 Arizona orange
2 Florida oranges
2 Florida lemons
1 Arizona navel orange
2 Arizona picking bags
2 Texas picking bags
12 bolls of Georgia cotton
1 lot Georgia raw cotton
2 Grapefruit from Florida
1 package Spanish moss from Georgia
1 Louisiana kumquat
2 New Mexico raw cotton mattresses
2 New Mexico cotton picking bags

Some of the cars mentioned in the above report originated in the southern states and came through the federal station at Mesilla Park. The contraband carried originated east of this point. In one instance live pink bollworm was taken and a sample for identification forwarded to Washington for identification, confirmed. This may indicate how pink bollworm reached Arizona.

It was recognized that lack of legal authority for federal inspection made it difficult to cover the search as thoroughly as at some of the border stations maintained by the states. Other interceptions briefly touched upon were potted plants from the Japanese beetle area, hosts of the European corn borer from the quarantined area and numerous violations of the white pine blister rust and Gypsy moth quarantines.

(Note: Fleury reports, as a result of a visit to southern border stations in December 1927, that over a period of approximately one month preceding that live boll weevil has actually been found twice at Blythe, twice at Daggett, and twice at Yuma. In two of these instances the cars bearing the contraband came through either a federal vehicular inspection station, a state vehicular inspection station, or one of the cooperative federal state stations maintained in the vicinity of the Arizona-New Mexico line and the cars originated east of these points.)

NARCISSUS BULBS.—Dr. F. R. Cole and C. F. Doucette—U. S. Bureau Entomology.—Discussed the narcissus bulb situation from a technical angle. Mr. Doucette developed the opinion as a result of investigations that the optimum time for treating bulbs on the Pacific Coast varied in accordance with the climatic conditions under which they were produced. Hot water dipping in July in San Diego County was comparable to a date in September for the Northwest. Apparently two or three weeks after the bulbs had reached full maturity was the best time. He indicated that bulb flies were distinctly more difficult to control than nematode by the hot water treatment. Dr. Cole stated that the lesser bulb flies, were represented by at least two and probably three species.

WHITE PINE BLISTER RUST.—S. N. Wyckoff and C. R. Stillinger, U. S. Office of Blister Rust Control.—Pointed out the present status of this pine, currant and gooseberry infection in the Pacific Northwest. Especially pointed out recent developments in control work and quarantine inspection, with reference to blister rust.

GENERAL TOPICS.—Plant shipments with soil were given consideration. It was pointed out that nematodes, plant disease fungi and bacteria are frequently carried in soil and not revealed by inspection. This was referred to the permanent committee on treatments to gain further data.

APIARY INSPECTION.—Uniformity in quarantine action with reference to apiary matters sought and a special committee to be appointed.

VEGETABLE WEEVIL.—Infestation in California, other states and countries reviewed insofar as data available. California studying the matter and restrictive regulations will be issued as it appears necessary on the basis of the information developed.

Resolutions passed embodied the following thoughts:

1. Commended Secretary Jardine on the retention of restrictive measures against grapes from Spain on account of Mediterranean Fruit Fly.
2. Urged every necessary action on part of Federal Horticultural Board to prevent spread of Mexican Fruit Worm and to stamp out infestation recently found in Texas.
3. Requested the states to guide their quarantine promulgations by the uniform basis of sound investigation and the Federal Horticultural Board to analyze all hazards before relaxing or modifying any federal quarantines.
4. Requested material aid in developing control measures either natural or artificial for European earwig from the U. S. Bureau of Entomology.
5. Recommended a technical international pest commission between the United States and Mexico to study all dangerous pests with reference to gaining full knowledge thereof and as to necessity of quarantine action on same and to recommend in an advisory way to the constituted authorities.
6. Urged additional funds for Federal Horticultural Board for pink bollworm clean up and for adequate maintenance of border and vehicular inspection stations.
7. Recommended closer coordination and greater uniformity in plant quarantine enactment and enforcements through the leadership of the Secretary of Agriculture in calling together chief plant quarantine officials in the United States or sectionally when special emergencies arise, such calling at his discretion and that such officials be made collaborators of the U. S. Department of Agriculture attending any meetings called by the Secretary at federal expense.

The officers elected were:

Chairman, Geo. G. Schweis, Nevada
Vice-Chairman, J. I. Griner, Washington
Secretary, W. C. Jacobsen, California
Representative on National Plant Board, M. L. Dean, Idaho

CHAIRMAN MONTGOMERY: The next will be a report from the National Board by Mr. Wilmon Newell.

THE NATIONAL PLANT BOARD

By Wilmon Newell, *Gainesville, Florida*

As this Section of the Association was primarily responsible for the creation of the body now known as the National Plant Board and as the latter appears to furnish, for the first time, an effective medium through which state and federal quarantine and inspection activities and policies may be correlated, brief mention of its organization may well be made a part of our records.

The unification or standardization of state and federal quarantine regulations, nursery inspection methods and certification of nursery stock have been the subjects of discussion for many years and particularly so since 1915.

Time forbids reference to the many plans which have been suggested and advocated; hence the present discussion must be confined to those developments which have contributed directly to the organization of the present National Plant Board.

At the Boston meeting of the Association of Economic Entomologists, in December, 1922, emphasis was placed upon the importance of unification of inspection laws and uniform certification. The Section of Horticultural Inspection adopted a resolution endorsing a uniform United States tag for interstate movement of nursery stock and stating that the qualifying inspection should be worked out between the United States Department of Agriculture and the state authorities.[1] At the same meeting a committee, consisting of Messrs. T. J. Headlee, F. M. O'Byrne, G. M. Bentley, Leonard Haseman and E. R. Sasscer, was appointed to formulate plans along the lines called for by the resolution.

At the Cincinnati meeting (1923–24) Dr. Headlee's committee presented a plan which called for a Board to be composed of three representatives from the Federal Horticultural Board and three from state inspection services; this Board to have power to control the inspection of all nurseries and to recommend nursery stock for movement interstate under tags to be issued by the United States Government. This proposal met with much protest from state officials and the committee's report was not adopted. However, the committee was continued.

During the ensuing year, Dr. Headlee's committee sent out questionnaires on the subject to state quarantine and inspection officials and again learned that the states were overwhelmingly opposed to federalization of nursery inspection and certification.

At the Washington meeting (1924–25) of the Association, the committee offered another suggestion, namely, that there be provided (1) a Board of country-wide composition for reviewing and passing on state quarantines affecting the interstate movement of nursery stock (2) Regional Boards for correlation of quarantine and inspection activities and (3) standardization, as far as possible, of regulations. This was satisfactory to the Section of Horticultural Inspection and was adopted.

The Western Plant Quarantine Board was already in existence, having been organized in May, 1919. The Central Plant Board was organized March 6, 1925 and during the same year there was organized the Middle Atlantic and Northeastern States Plant Conference Board. Representatives of these three regional bodies met at Kansas City in December, 1925, and formed a temporary organization.

Quarantine officials of the southern states perfected the organization of the Southern Plant Board at Atlanta in February, 1926.

Each regional organization elects two representatives to the national organization.

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[1] Journ. of Ec. Ent., Vol. XVI, p. 167.

While the regional boards were being organized the proposed national body was usually referred to as a "Board of Review," which seemed to express the main original idea in the mind of the Association of Economic Entomologists with reference to the functions of such a body. As the plans progressed it became evident that plant quarantine problems would perhaps assume a greater relative importance in the activities of such a national body than would questions of nursery inspection and certification.

Another question debated at length was whether or not the proposed national body should include in its membership representatives of the federal government or whether it should be, *per se*, an organization representing state departments exclusively. This point was not settled until the eight representatives of the four regional boards met at Washington, June 25, 1926, to perfect the permanent organization. They were of the opinion that the federal government should not have representatives on the Board and a sounding out of the membership of the Federal Horticultural Board disclosed the fact that the latter Board held to the same opinion.

The name of National Plant Board was adopted at the Washington meeting in June, 1926, a constitution was adopted and officers elected. The regional representatives making up this Board were:

Western: Lee A. Strong and M. L. Dean
Eastern: W. A. McCubbin and W. C. O'Kane
Central: Frank N. Wallace and S. B. Fracker
Southern: Geo. G. Becker and Wilmon Newell.

The officers elected were: Lee A. Strong, Chairman, Wilmon Newell, Vice-Chairman and W. A. McCubbin, Secretary.

During 1926 Mr. Becker resigned and R. E. McDonald was appointed in his place. During 1927 Mr. Fracker resigned and A. G. Ruggles was selected to succeed him. Otherwise, the personnel of the Board is the same as it was when organized.

At its meeting in Washington, June 25–26, 1926, the Board went on record as opposing the imposition of inspection and license fees in connection with the inspection and sale of nursery stock. A number of simple, but important, recommendations with reference to the simplification of nursery inspection practices were prepared for transmission to the regional boards. The recommendation was also made that a state considering the issuance of a quarantine or regulation of interest to another state should send notice as far in advance as possible to the Federal Horticultural Board and to others in interest. A committee was appointed to prepare, if possible, a definition of "nursery stock" which could be used uniformly by the states. Joint conferences were held with the Federal Horticultural Board with reference to a number of domestic and foreign quarantines, these conferences making for clarification of a number of important points.

At the third meeting of the Board, held in Washington, May 12–13, 1927, subjects receiving consideration included the Mexican fruit-fly situation in Texas, certification of greenhouse plants, exclusion of certain foreign-grown plants and the occurrence of *Aserica castanea* in New York and Pennsylvania. Steps were inaugurated looking to a definite formulation of the principles which should govern plant quarantines. A joint session was again held with the Federal Horticultural Board at which, among other things, certain aspects of the European corn borer and Japanese beetle quarantines were discussed.

The Federal Horticultural Board has accorded the National Plant Board a most friendly and cordial reception and apparently welcomes the opportunity afforded for discussing, informally, with representatives of the state inspection services, various matters of common interest which arise from time to time.

The National Plant Board does not, in itself, possess any authority and it has no legal status. It has only such authority as may be conferred upon it by its constituent regional boards. It represents, however, the state quarantine and inspection departments of all the states: an active agency to represent them and to carry out their wishes.

The Board is still young but it may confidently be expected to have some weight in matters of policy with reference to both domestic and foreign quarantines and to serve as a clearing house for the various state officials and as a useful correlating agency between the states and the Federal Horticultural Board.

CHAIRMAN MONTGOMERY: All of these reports are now open for discussion.

C. L. MARLATT: With reference to what Mr. Strong said, I am very heartily in favor of getting into any relationship with the plant quarantine authorities of Mexico, which is possible. I agree absolutely with what he said, it can't do any harm, and it may do a lot of good, and certainly it will give them encouragement. We have a lot of problems that we can not work out except with the aid of Mexico. The bollworm is one of them. We are bound to have the bollworm in the United States until Mexico can cooperate in cleaning up.

We have the new problems of the Mexican fruit worm where we want cooperative work. There are other pests in Mexico which we are trying to exclude, and we want to do it fairly. We want them to help us and cooperate with us, so that we can do it without putting undue restrictions on commerce between the two republics. I am very heartily in favor, and I think the Board and Department are heartily in favor of that or any steps in the direction of cooperation, at least in the direction of counsel and conference, with the hope that something good will come from it.

I have listened with much pleasure to the reports of all the boards, and I look for a great deal of usefulness from the boards and the central body. It ought to be in some way a material part of the Federal plant quarantine service. That may come.

CHAIRMAN MONTGOMERY: Is there any further discussion or comment?

LEE A. STRONG: I want to make one thing clear. I mentioned the Mexican situation just to illustrate the general trend, as we see it, toward getting together on the quarantine affairs and uniformity. We had a very hearty response from the Federal Horticultural Board with reference to the recommendations we made to that situation.

I also want to say that the National Plant Board, at its last meeting in Washington, D. C., in June or May submitted certain recommendations to the Federal Horticultural Board, and those recommendations have received the very careful consideration of the Board. We were very much pleased with the consideration given to the recommendations by the Federal Horticultural Board. It showed to us they were certainly welcoming our suggestion and any assistance we might be able to give.

CHAIRMAN MONTGOMERY: Dr. Marlatt will now review the work of the Federal Horticultural Board for the past season.

THE WORK OF THE FEDERAL HORTICULTURAL BOARD IN 1927

By C. L. MARLATT

[Digest Based on Stenographer's Notes.]

A change in organization has been consummated during the past season and another one of primary importance is pending. The work of the Board has been divided into the foreign and domestic fields, and Mr. Sasscer and Mr. Fracker, respectively, have been placed in charge of those divisions.

There is now pending before Congress a recommendation of the department which will bring together the plant quarantine and regulatory work heretofore handled by the Federal Horticultural Board, the Bureau of Entomology, and the Bureau of Plant Industry into a Plant Quarantine and Control Administration, allowing the former bureau to direct its activities toward research work in entomology. This is in line with a similar reorganization of the Bureau of Chemistry a year ago.

Two subjects of importance have come up in the domestic field, namely, the spread of the pink bollworm into southwestern New Mexico and southeastern Arizona, and the Mexican fruit worm invasion of the Lower Rio Grande Valley of Texas.

About ten thousand acres of cotton are involved in the pink bollworm spread to the west and a thoroughgoing cleanup is being made of all the cotton areas of that region. Cotton there is grown only in territories where water can be secured, that is, in isolated valleys between mountain ranges and arid stretches of desert. The work is being done with the help of the deficiency appropriation of $90,000, which became available about the middle of December.

Doctor Baker will discuss the Mexican fruit worm subject in a later paper on this program. The department first received information regarding the occurrence of this pest in the United States in April. As a result of a conference with Texas officers, the National Plant Board, which was meeting in Washington, and others interested, a program of eradication was determined upon, based on an annual seven-months starvation period to be maintained by eliminating all host fruits in which the fly could breed between the first of March and the first of October. This is the period during which the grapefruit, the important commercial crop of the region, is developing, and throughout most of the period the fruit is too green to be attractive to the fly. During the past year this host-free period was maintained by the owners by picking such fruits as guavas, sour oranges, and peaches from the trees, but the plans for a permanent protective program involve the destruction of such trees as normally produce fruit during the summer host-free period. The owners' cooperation in picking the fruits was secured by active publicity campaigns in May and July, respectively, the second campaign being directed to those fruits which developed after the first one had been completed.

The work of cleanup, which had been urged and started by representatives of the A. & M. College of Texas and by the State Department of Agriculture immediately following the discovery of the pest, was carried forward by a detail of some 15 inspectors from the pink bollworm force of the Federal Horticultural Board, and these inspectors were placed under the immediate direction of Mr. McDonald, of the Texas State Department of Agriculture. This work involved first the elimination and disposal of left-over grapefruit in orchard culls and elsewhere, followed by a cleanup of all summer-ripening fruit, and these phases of the work, lasting through until the first of September, were done without funds and with loaned inspectors, as indicated. The first of September funds to continue the work were obtained from the Bureau of Entomology, and the direction from that time on was turned over to Doctor Baker, working in cooperation with Mr. McDonald, and with the actual transfer of some of the Board's men who had been engaged in the project up to that time. On the assembling of Congress, steps were taken to secure the inclusion in the first deficiency bill of $100,000 to continue the work for the balance of this fiscal year. To avoid changing direction in the midst of the season, the work will be continued under the supervision of Doctor Baker for the Board until July of the next fiscal year, after which it will be taken over fully under the reorganization as a part of the regulatory work of the new Plant Quarantine and Control Administration.

There is no project which the Board and Department have undertaken involving drastic action that has received greater local support or more hearty cooperation. Every effort is being made by the local orchard owners not only to comply with all the provisions of the quarantine and the eradication program, but also to prevent the further smuggling of Mexican fruit across the Border, from which the fruit worm infestation seems in part at least to have arisen.

The date scale eradication project has been revised and put on a much stronger basis. The funds hitherto available have been inadequate to give this work the proper speed and efficiency to bring it to a conclusion within a reasonable time and, in fact, to assure a successful conclusion. The presentation of this matter to the Budget led to the securing in the first deficiency bill of this Congress of an increase of $25,000 for use in large part or, if necessary, altogether during the present fiscal year, with the expectation that provision will be made for a continuation of the work on this larger scale thereafter until eradication has been achieved or until its accomplishment is shown to be impossible.

Three important foreign problems have come up during the year, involving Argentina, Spain, and Italy.

The finding of some fruit infested by fruit flies from Argentina over a year ago raised the question of the possible presence of fruit flies in the Argentine orchard districts. At the request of that government, we agreed to aid Argentina in determining what infestation might exist there. Mr. Kisliuk was assigned by the Board to make this survey and proved to be a very efficient man for that sort of foreign service. He demonstrated to our satisfaction that the infested fruit came from a region in the northern part of Argentina and that the main fruit districts of that country, from which exports are usually made, not only have not been infested by fruit flies, but are so isolated geographically and commercially that they are fairly well protected from invasion by the insects.

This result as to freedom of the main fruit districts of Central Argentina from fruit flies confirmed the results obtained by a similar very thorough field investigation made at the instance of the Board by Mr. Moznette some two years previously. These findings warranted the Department in authorizing the continuance of entry of fruits from these districts, but such entries are conditioned on the Government of Argentina maintaining adequate internal quarantine restrictions to protect these districts and also on the meeting of certain requirements with respect to fruit exports to the United States. These requirements are incorporated in all permits, and are as follows:

1. Shipments shall be certified as to origin by appropriate officers of the Argentine Government.
2. Each crate or container shall be marked to indicate the Province of origin.
3. The shipments shall be safeguarded from point of origin to embarkation at Buenos Aires.
4. Compliance with these conditions shall be the basis of issuance of consular invoice.
5. The shipments shall be subject to thorough inspection by inspectors of this Department upon arrival at New York or other northern port specified in the permit.
6. Refusal of entry shall follow determination of infestation by fruit fly, both as to the shipment in question and as to other shipments from the same district which may be en route, and such refusal of entry shall also follow, as to the Province concerned, any determination of fruit fly infestation which may result from surveys hereafter made.

The result in Argentina encouraged Spain to ask for a similar survey, and Mr. Kisliuk was also assigned to that work.

It will be recalled that Spain has been the subject of two or three rather careful surveys, and that the fruit fly is widely distributed in practically all fruit sections of that country. The conditions, therefore, are widely different from those in Argentina, and in fact there was very little likelihood that a resurvey would show any situation which would warrant any modification of the existing restrictions on the entry of Spanish fruit into the United States. The survey, however, was made in the interest of its actual value as a determination of conditions and for its educational value on Spain, should the situation be such as to clearly indicate the danger of her fruit to the United States. Mr. Kisliuk found general infestation throughout the Spanish grape district, which was particularly in mind, including regions which the growers and the Spanish Department of Agriculture had made considerable effort to clean up. He also found other fruit, not only in this district but elsewhere, more or less infested with the fly. Mr. Kisliuk was accompanied by Spanish experts and others who worked with him and witnessed the finding of infestations, with the result that the situation has been accepted by Spain and a full appreciation has resulted of the very patent fact that these restrictions are based purely on pest reasons and have no commercial significance.

Later in the summer, the department was urged by the Spanish authorities to have Mr. Kisliuk visit the Canary Islands to determine whether the rather important tomato crop produced on these Islands was at all infested with fruit fly, in the interest of possible shipment of more or less of this crop to the United States. Mr. Kisliuk was given authority for such inspection and did a very thorough piece of work on these Islands. In some fields he literally cut up the whole crop of tomatoes, but in no case did he find any infestation by fruit flies, even, as in one instance, where the fruit flies were swarming in citrus orchards bordering the tomato field. Permits are, therefore, now being issued for the entry of tomatoes from these Islands but, as with all other fruit and vegetable importations, subject to inspection at the port of entry.

Another problem which has involved some difficulties is that of the importation of chestnuts from Italy. In Europe, these nuts are subject to attack by the chestnut weevil and the chestnut codling moth, the latter attacking also walnuts and other nuts. Conferences had been held with Spanish importers and commercial representatives of Spain in the United States, with the idea of having steps taken in Italy to remedy the situation, or at least to disinfect the nuts so that the worms in any of the infested nuts would be killed. It is too long a story to give the details, but the outcome was that Italy agreed to treat the nuts under methods that had been suggested by us so as to accomplish this result. Nevertheless, a number of shipments when they arrived at New York showed heavy infestation with living larvae, and further entry of these nuts was refused unless and until arrangements could be made to have them given hot water treatment at New York under the supervision of officers of the Board. After a very short time, the necessary arrangements for such treatment were made by the importers and such treatments have been given these and all subsequent shipments. Incidentally, it may be noted that these treatments were completely effective in destroying the worms, and it is believed that hereafter they will be given in Italy to avoid the very considerable increased cost and difficulty of treatment at New York.

In closing, I should like to correct an impression which some of you have indicated at various times, viz., that the Board may be affected in its judgment relative to quarantine matters by pressure from other Departments of the Government, based on effect of proposed quarantine restrictions on treaty considerations or as to possible reactions on our own exports. I can assure you that the Board has never experienced any such pressure, and that the attitude of the State Department particularly has been one of active support. The State Department has throughout made every effort to see that the necessity for the quarantine or restriction on account of some dangerous pest is made clear to our own representatives abroad—diplomatic and consular—and also to the diplomatic and other officers of the countries concerned. The necessity for the action taken has been fully understood and appreciated by that department. There has never been any effort to get the Department of Agriculture to change its judgment about such quarantines or restrictions, but merely, as indicated, to aid in seeing that they are understood, and this action has been most helpful.

CHAIRMAN MONTGOMERY: Are there any questions to be addressed to Dr. Marlatt?

WILMON NEWELL: I am sure we appreciate to the utmost this very interesting and frank account of the very wonderful work accomplished by the Federal Horticultural Board the past year.

CHAIRMAN MONTGOMERY: While not on the program, I feel sure you would be glad to hear some report from our neighbor of the North, Mr. McLaine.

L. S. MCLAINE: This is an unexpected pleasure, and I am sorry I am not at all prepared. However, I take great pleasure in attending these conferences on horticultural inspection. We gain a lot of knowledge from these meetings, and we endeavor to put some of it into practice.

I have also attended a number of meetings of the Western Plant Quarantine Board as a guest, and I noticed in the last few years, as was mentioned in the address by the Chairman today, and also in the reports by the various district plant forces, the advisability of closer inspection of nursery stock, particularly in regard to the inspection at time of packing.

For a number of years in Canada we have been advocating that very point, and I am very sorry to say we have had a great deal of difficulty of late with regard to many of the shipments that we have been receiving from the United States. The majority of them are accompanied by so-called blanket certificates, some of which are valid for a year and, in some cases, for a period of 18 months. You can readily understand what this type of certificate means. On the other hand, in all fairness to certain states, I do wish to say they have been making a very strenuous effort to furnish a valid certificate for shipments destined to Canadian territory. In fact the situation has become so acute we are calling a public hearing, to be held the latter part of January, to reconsider our present regulations with regard to shipments from the United States at the present time.

We have regarded the United States more or less as a favored nation, in view of the fact that we have not been requiring the reinspection of shipments from this country. We do require reinspection from all other countries. It has been necessary for us to reconsider the policy which has been in vogue since 1923. What the outcome of the hearing will be, it is impossible to say, but I imagine we will require the terminal inspection of all shipments coming to us from the United States, and a proper certificate to accompany such shipments. I feel that this will work out to the mutual benefit of all. It will strengthen your hands, particularly state officials, and it will also insure that our people will get healthy material.

I am afraid the message I have brought is not a very happy one, but I feel that it will work out to the mutual benefit of all. I wish to thank you, Mr. Chairman, for this opportunity of saying a word.

CHAIRMAN MONTGOMERY: We will stand adjourned until one-thirty o'clock.

The meeting adjourned at twelve o'clock.

Tuesday Afternoon, December 27, 1927

The meeting convened at one-thirty o'clock, Chairman Montgomery presiding.

CHAIRMAN MONTGOMERY: We will resume the program for the afternoon. The Chair is going to ask that your immediate Past President occupy the Chair.

Mr. L. A. Strong took the Chair.

CHAIRMAN STRONG: The next subject is "The Present Status of the Pink Bollworm and the Thurberia Weevil." I understand it was not possible for Mr. Becker to be present. Mr. McDonald has the paper prepared by Mr. Becker. Mr. McDonald read the paper.

THE PRESENT STATUS OF THE PINK BOLLWORM AND THE THURBERIA WEEVIL

By GEO. G. BECKER, *San Antonio, Texas*

The discovery of the pink bollworm in western New Mexico and eastern Arizona and the discovery of the Thurberia weevil in Cochise County, Arizona, mark the most outstanding recent developments in the status of these two cotton pests. The factors which were responsible for the extension of the range of the pink bollworm to the recently infested territory are likely the same which would operate to make possible the spread of either the pink bollworm or the Thurberia weevil to nearby cotton plantings.

(Withdrawn from publication)

CHAIRMAN STRONG: One of the important problems which the Federal Horticultural Board has undertaken is the control of narcissus inspection problems in conformity with the quarantine placed on foreign bulbs.

Mr. Fracker has made a study of the inspection problems being met with in the enforcement of this quarantine. He has not been out to California to investigate our problems. If he will come out there we will show him some problems in connection with narcissus inspection.

NARCISSUS INSPECTION PROBLEMS

By S. B. Fracker, *Washington, D. C.*

Abstract

Over 95,000 narcissus bulbs are being grown in the United States at the present time. They must all be inspected twice and certified before shipment is permitted. All but sixteen States grow some narcissus and in many of them one or more bulb-fly or eelworm infestations have been found. Recommended changes in the present procedure relate to financial and technical assistance to the States, investigations, and minor changes in the quarantine regulations.

Several developments of recent years have tended to bring the Federal Horticultural Board and the State inspection services in tocloser contact with each other, and to result in greater uniformity in inspection and certification procedure throughout the country.

One of the more important of these is the attempted eradication of such bulb pests and bulb flies as have recently become established in the United States. It will be recalled that when the commercial importation of narcissus was discontinued on January 1, 1926, this action was ardently supported by the bulb-growing States. As a corollary to the restrictions on importations, the eradication of such infestations of nematodes and bulb flies as exist in this country was undertaken by the States and in order to prevent reinfestation, federal certification is now required for the interstate movement of all narcissus, the inspection being made by State nursery inspection officers as collaborators of the federal department.

The first problem of a quarantine organization is to determine the most desirable procedure from the biological standpoint, and the second one is to adapt that procedure to the already established channels of production and distribution of the industry affected.

The methods of bulb production and distribution in this country involve many different occupations. Up to about two years ago, the original source of supply of bulbs in the United States was the importer, who secured them from planters in Europe. Such importations are still being made with respect to new varieties and propagating stock, but the importer at present is a much less essential link in the chain than heretofore. Such bulbs as are now coming from Europe are planted for propagation purposes and retained on the same premises for a period of two years before being forced, or released for garden planting.

The present source of commercial supply, therefore, consists of the planters who grow the bulbs outdoors and propagate them for increase. This wholesale bulb industry has recently been expanding and there are now on our list 440 producers of daffodils and jonquils and 96 producers of paper whites and other polyanthus types who grow the bulbs outdoors, most of them offering the bulbs for sale for forcing purposes.

The available supply is in excess of 45,000,000 bulbs of the daffodil type and 50,000,000 of the polyanthus, or a total of over 95,000,000 bulbs being grown in the United States at the present time.

There are thirteen States in which the number of outdoor-grown narcissus bulbs exceed a total of 1,000,000 namely, Florida, Texas, New York, Washington, Oregon, South Carolina, Michigan, Virginia, New Jersey, North Carolina, Illinois, California, and Ohio, in the order named.

These outdoor-grown bulbs are sold to four classes of customers: (1) to florists for forcing in greenhouses during the winter months; (2) to home owners who grow the paper whites as house plants and the daffodils outdoors in the home gardens; (3) to retail grocers, hardware and five-and-ten-cent stores, who resell them over the counter to home owners; (4) to dealers who in turn resell the bulbs to any of the first three classes of customers named. The proportion of interstate shipments made by dealers is proving to be much greater than had been anticipated.

It is clear from this outline that there are two classes of ultimate consumers, viz., professional florists and home owners. When it comes to ultimate consumption, however, bulbs differ from many other kinds of products in the fact that they do not pass out of existence when their principal purpose is served. Home owners usually discard the bulbs which have been forced in the house and seldom resell the daffodils, although they may replant them on their own premises. On the other hand, since the commercial value of narcissus bulbs is increasing, there is a growing tendency on the part of florists to sell bulbs which have been forced. These are turned over to the wholesalers who grow them outdoors for the three or four years necessary for the purpose of rejuvenation. In at least one case also, forced daffodils are being sold to consumers for outdoor planting.

Narcissus inspections are made at least twice a year, as this is considered the minimum number of examinations which will give a reasonable idea of pest conditions. The first or blossom-season inspection is devoted primarily to the detection of eelworm infestation, which cannot be satisfactorily determined after the bulbs are dug. Several States are making a number of successive blossoming inspections owing partly to the fact that both early and late varieties are present in the fields.

The first inspections of the year are made in Florida early in January, the paper whites beginning to blossom there during the holidays. Field inspections of these polyanthus types in the south are completed in February and storage inspections begin the latter part of May. Where greenhouse inspections of paper whites are necessary in the northern States, the work occupies practically the same period.

Daffodils are few in number in the Gulf Coast region, but what there are, bloom shortly after the paper whites and are examined at that time. As the season progresses, inspections are made farther north but they should be completed in the Canadian border States before the middle of June.

Storage inspections can be undertaken as soon as the bulbs are lifted, and are in progress throughout the United States, on all varieties, during June, July and August.

The State inspectors are having little difficulty with diagnosis of the bulb flies, as *Merodon equestris* infestation is almost unmistakable when the suspected bulb is cut open. *Eumerus* larvae can be discovered more readily than *Merodon* in stored bulbs, because they are usually near the exterior and the bulbs show evidence of decay. In the field, gaps in the row are indications of fly infestation and should always be investigated. In only a few cases are fly-infested bulbs received at Washington for confirmation although such material is always welcome.

The greater bulb fly, *Merodon equestris*, appears to have been discovered this year only on the Pacific Coast and in Illinois, Rhode Island and Utah, but is known to have been present in the past at least on Long Island in New York State.

The lesser bulb fly, *Eumerus strigatus*, is being picked up in larger numbers and has been reported from California, Illinois, Kansas, Michigan, New Jersey, New York, Oregon, Pennsylvania, Rhode Island, Virginia and Washington.

Eelworm infestations are more difficult to discover, dwarfing in the row and nodules in the leaves being the most pronounced symptoms. Inspected material, especially when found in the stored bulbs, should receive microscopic determination. The identification of eelworms is largely being made at Washington by Doctor N. A. Cobb and his staff. Some of the suspected material sent in by the States has been found to contain saprophytic but no parasitic nematodes, while other material shows not only *Tylenchus dipsaci*, but also other apparently parasitic species, including *Aphelenchus apiculatus* and an unidentified *Rhabditis* or *Cephalobus* larva.

Eelworm infestation has been reported in ten States: California, Michigan, Mississippi, Ohio, Oregon, Rhode Island, South Carolina, Texas, Utah, Wisconsin.

The States which report no narcissus bulbs, or have not reported and are believed to grow none for sale as bulbs, are: Arizona, Colorado, Delaware, District of Columbia, Idaho, Maine, Montana, Nebraska, Nevada, New Hampshire, New Mexico, North Dakota, Oklahoma, South Dakota, Vermont, West Virginia and Wyoming.

The States in which one or more inspections were made but no infestations of any of the three pests discovered are Alabama, Arkansas, Connecticut, Florida, Kentucky, Louisiana, Maryland, Massachusetts, Minnesota, and North Carolina.

Information is incomplete on this subject from Georgia, Indiana, Iowa and Tennessee.

The number of white certificates showing freedom from infestation for 1927, reported to date by the State inspectors amounts to 85 covering 41,385,200 paper white and other polyanthus type bulbs, and 222 covering 27,858,301 daffodils and jonquils.

The number of red certificates showing treatment on account of infestation in 1927, reported to date is 6 covering 9,156,695 polyanthus type bulbs, and 150 covering 14,141, 620 daffodils and jonquils.

With respect to the methods of certification there have been some difficulties which can be adjusted next season. The regulation with which there has been the most difficulty to get the growers to comply, is that which requires them to supply an affirmation regarding the prior certification of the planting stock. Only 125 growers supplied such an affirmation this past year, the remainder of those issued white certificates either having been supplied with these certificates by the State inspectors without the required affirmation or having planted the bulbs dug in 1927 prior to the year 1926, in which case no affirmation was required.

An application form has been prepared and will be sent out shortly in which the affirmation is part of the application itself. This will, it is believed, simplify the procedure and make it easier for the inspectors to determine the source of the stock before the first inspection is made.

A second problem which has arisen as inspection progressed is that of one or two State inspectors who have misunderstood the provisions regarding roguing and have issued certificates after having eliminated the visibly-infested bulbs in the warehouse. In several cases the certificates had been issued and the bulbs of the lot from which the visibly-infested ones had been removed were being shipped under white certificates and without treatment before the circumstances were discovered at Washington, and therefore could not be remedied. It is believed that less difficulty from this source will arise next season as State entomologists and nursery inspectors of the various States are becoming more familiar with the narcissus work.

The object of requiring treatment of the bulbs in the event that even a slight infestation with either bulb flies or eelworms is found at the time of warehouse inspection is the difficulty of sorting infested from uninfested bulbs in storage. The details of this situation are given in HB-195, a mimeographed circular issued by the Federal Horticultural Board in 1926, where it is shown that not all the infested bulbs can be discovered by an examination of the exterior. The results which this circular describes were largely inspections for eelworms and greater bulb flies.

Having in mind the purpose of narcissus inspection, namely, the total eradication of some or if possible all species of parasitic bulb nematodes and bulb flies in the United States, and in consideration of the reports which have come to the Federal Horticultural Board and the limited number of observations, the writer has been able to make in the field this past season, it appears that the needs of the narcissus inspection work may be outlined somewhat as follows:

(1) Financial assistance for a number of States with large plantings of narcissus bulbs and with a nursery inspection staff inadequate to give them proper attention. It will be very difficult and perhaps impossible for the federal department to supply such financial assistance during the season of 1928, but it is hoped that by the summer of 1929 something can be done along this line.

(2) More technical assistance to the inspectors in the way of diagnosis of the pests concerned. This should include the employment of one or more specialists who would work with the inspectors in the different States, and it therefore involves a financial problem related to the need just described.

(3) Investigations of at least two especially pressing problems: (a) further facts relating to the taxonomy, host relationship, and economic importance of the lesser bulb fly, and (b) improved treatments, to avoid the objections to both the hot water treatment and the carbon disulphide treatment where the bulbs are to be grown in greenhouses immediately afterward.

(4) Minor changes in the regulations (a) requiring some form of certification on all bulbs moved interstate in order that inspectors at destination may have evidence that the bulbs are free from infestation or were treated; (b) clarification and simplification of the requirements for the

interstate movement of bulbs just after forcing by florists; (c) authorization for the interstate movement of bulbs across State lines to treating plants. It appears dangerous to permit the transcontinental shipment of large quantities of fly-infested bulbs for treatment at destination but there are a number of States within which no treating plant exists where the number of bulbs does not justify the purchase by any individual grower, and in such cases the movement of bulbs to a plant in a neighboring State for treatment appears desirable.

The Federal Horticultural Board is giving consideration to a revision of the regulations at the present time and any suggestions along these or other lines on the part of State inspectors who have had to meet narcissus inspection problems will be appreciated.

CHAIRMAN STRONG: Is there any discussion of this subject?

L. S. MCLAINE: Has it been definitely established that the lesser bulb fly is a primary or secondary pest?

S. B. FRACKER: I should like to ask Dr. Baker to discuss that problem, if he cares to do so.

A. C. BAKER: As yet we have not arrived at an opinion on that point. There appear to be several species which have been confused in the past records. It will be necessary now to determine the response of each one of those species.

S. B. FRACKER: If my understanding is correct, at least one species is injurious to the healthy bulbs.

P. A. GLENN: We found the bulb fly attacking the healthy bulbs.

CHAIRMAN STRONG: We have found some surprises out West in the lesser bulb flies. Dr. Cole and Dr. Doucette have been working on the bulb fly. I think they are going to be ready, before a great while, to give us some valuable information, with respect to the biology and treatment. I think they are discovering some rather remarkable differences in the time of treatment, which is going to be of great value in doing our work throughout the western states, at least.

H. F. DIETZ: In Indiana we find we are getting bulb mites on a lot of things. We had one case where practically 10,000 bulbs of one variety of gladiolus were attacked by the bulb mite. The bulbs were stored in a place where narcissus were previously stored. In such storage inspection as I made this year I found the bulb mites constantly present. That does not only apply to Indiana. It applies to several other States who have passed the rule to examine bulbs.

Miss Bessie M. Broadbent: With respect to the bulb mite, in the experience I have had so far in connection with that problem, I do think there is a difference in the susceptibility of different bulbs to the attack of bulb mite. They might not be primary in connection with the common bulbs, and yet cause what appears to be severe and, perhaps, primary injury on lilies and certain other things, where the bulb mite alone seems to be the cause. I believe there are some observations in California in connection with callas where the bulb mite is held responsible for the injury.

Chairman Strong: Is there anything further on this bulb question? The next paper is by Mr. Detwiler of the Bureau of Plant Industry.

DEVELOPMENTS IN WHITE PINE BLISTER RUST CONTROL IN THE UNITED STATES

By S. B. Detwiler, *Senior Pathologist in Charge, Office of Blister Rust Control, Bureau of Plant Industry, U. S. Department of Agriculture*

A big wave of infection, such as took place in 1927, causes the most significant changes in the blister rust situation. Some spread and intensification takes place each year but periodically there are years which are especially favorable for development of the rust. These exceptionally heavy infection waves tend to occur at intervals of 3 to 5 years. This appears to be due partly to the fact that an infected pine tree does not produce the blister rust spores that repeat the rust cycle until 3 years or more after infection takes place on it. However, after the rust is established, the chief cause of these infection waves is the occurrence of favorable infection seasons. Cool, moist summers make favorable conditions for the spread of the rust.

The disease is caused by a fungus which was introduced into the United States from Europe. Unlike some important plant pests, no parasitic enemies of this fungus have been discovered which can be introduced here to help effect control of the disease. Its control is *entirely dependent upon human action*, direct or indirect, in bringing about the local segregation of its alternate host plants (Ribes and five-leafed pines). Once a forest area is cleared of Ribes, it tends to remain free of these plants if a dense forest cover is maintained.

Control measures are applied in most cases to protect commercial white pine forests by destruction of Ribes (currants and gooseberries). Regulatory measures to assist in securing control of the rust are of fundamental importance; first to retard spread of the disease, and second, to secure the destruction of currant and gooseberry plants in control areas. This paper summarizes the blister rust control situation from its regulatory aspect.

STATUS OF INFECTION BY REGIONS

NEW ENGLAND. The rust was introduced from 1897 to 1910 and intensified from 1910 to 1916. Accumulative damage to pines has been severe on unprotected or lately protected areas in the northern half of the white pine region. In the southern half of this region damage is light, as yet, due to sparse distribution of wild Ribes.

NEW YORK. Introduction took place 1900 to 1909, and intensification from 1909 to 1919. Damage is heavy in the pine region of the Adirondacks, and light damage has occurred in several additional counties in the northern half of the state. In the southern and western half of the state the rust is still in the very early stages of intensification.

NEW JERSEY AND PENNSYLVANIA. Introduction took place from 1905 to 1909 on imported stock, and on local nursery stock in New Jersey up to 1916, but intensification was largely prevented by sanitation-cutting of pines. Since 1916 there has been some intensification of the rust in several counties in northern Pennsylvania. A survey in 1927, conducted through the public schools, shows that the rust has spread on Ribes throughout Pennsylvania and is established on native pines on the Cook forest in Clarion County. New Jersey, in 1927, had more infected Ribes distributed over seven counties than were found in any previous year, but no centers of infected pines have been found.

SOUTHERN AND CENTRAL STATES. The blister rust apparently has not spread into Delaware, Maryland, Virginia, West Virginia, the Carolinas, Georgia, Kentucky, Tennessee, or in the Ohio Valley and central states. It is probable that the rust spread south of Pennsylvania in 1927, since rust was found in counties adjacent to Maryland and West Virginia. Scouting was very limited in these states in 1927 because of lack of funds for this purpose. Shipments of infected pines were traced and destroyed in Virginia in 1911, Ohio in 1910-11 and 1916-17, Indiana in 1910, Iowa in 1917, and South Dakota in 1917. No spread from these centers has ever been found.

LAKE STATES. Introduction of the rust occurred in 1908-09, but at very few points. The disease was found on Ribes in 17 counties in Michigan in 1927, whereas it had previously been found only in two counties. The rust has now reached south to the Indiana line and north of Grand Rapids. In Wisconsin and Minnesota little scouting was done in 1927, but scouting in previous years shows that the rust is approaching the light damage stage in the southern half of the pine region in these states. Control work since 1917, done where centers of infected pines were found, has met with marked success in decreasing the rate of spread and establishment of the disease in the Lake States. This success is apparently due in part to the limited distribution of white pines in the infected territory, so that pine infection centers could be readily found and eradicated.

PACIFIC COAST STATES. The blister rust was introduced at Vancouver, B. C. in 1910, spread rapidly to distant points, and has reached the heavy damage stage in the coast region of British Columbia. It is intensifying heavily on pines in the Olympic Peninsula of Washington, and is rapidly becoming established in northeastern and southwestern Washington. In northwestern Oregon, Ribes were infected in two additional counties in 1927, making a total of five counties infected since 1925. The rust has not yet been found in southern and eastern Oregon, nor in California.

IDAHO AND MONTANA. The rust was found for the first time in Idaho, in 1927, and also in the southeastern portion of British Columbia near the Montana line. These infections were found on Ribes, but the disease is in the intensification stage on pines over a large area in eastern British Columbia extending from Revelstoke to a point 30 miles north of Idaho. Blister rust infection appears to have first occurred in eastern British Columbia on *Ribes nigrum* L. (European or cultivated black currant) in 1917, through natural spread from the coast region. In 1927 the rust was very prevalent on cultivated and wild Ribes in the eastern part of the Province.

The long-distance spread of the rust from infected pines to *Ribes nigrum* was further proved in 1927 by finding the rust on cultivated black currants north of Prince George, 350 miles north of the established range of five-leafed pines.

ROCKY MOUNTAIN STATES. White pine blister rust has not been found in these states south of northern Idaho. The five-leafed pines of this region are considered of secondary importance for timber production, though high in scenic value. Some foresters consider that limber pine has commercial possibilities in limited areas, and it has value for watershed protection. In view of these facts it would be well for the Rocky Mountain States to start educational campaigns to secure elimination of *Ribes nigrum*.

STATUS OF GENERAL CONTROL WORK

Blister rust control work is conducted in close cooperation with the regulatory authorities of the pine-growing states. The work is mainly of service and educational character, but it is of primary importance that adequate regulatory authority exist for use when necessary. As infection increases in a state and a variety of control problems arise, it becomes expedient to enact specific blister rust control laws.

Maine, New Hampshire, Vermont, Connecticut and New York have special blister rust control legislation giving ample regulatory authority to the state forestry departments. Massachusetts, Rhode Island, Michigan, Illinois, Washington, Oregon and California have special legislation dealing with plant pest control under which the state agricultural departments can establish and enforce blister rust control measures. The other states operate under their general horticultural and nursery inspection laws. Blister rust control areas have been legally established in Maine, New Hampshire, Massachusetts, Rhode Island, New York and Idaho, thus enabling interstate shipments of blister rust host plants to be excluded from these areas in accordance with the provisions of Federal Plant Quarantine No. 63.

The general aim of blister rust control is systematic local segregation of five-leafed pines and Ribes on areas best suited to their respective production. *Ribes nigrum*, however, is being generally eradicated because of its high susceptibility to infection, great pine infecting power and small economic importance. The opposition of the United States Department of Agriculture to the growing and planting of *Ribes nigrum* in the United States is generally understood, and authorities in the pine-growing states are giving good cooperation in the elimination of this plant. This is being accomplished by the restrictions of Federal Quarantine No. 63 on the interstate shipment of this plant, and by educational measures, supported by state regulatory action when other means have failed to get results. Over 90 per cent of black-currant owners remove their plants willingly when asked to do so. Massachusetts, New York, Montana, Idaho, Washington, Oregon and California have declared *Ribes nigrum* a nuisance plant; its eradication from Montana, Idaho, and Oregon has been completed and is in progress in the other four states. Michigan has quarantined 18 infected counties against possession and planting of *Ribes nigrum*.

Nurserymen desiring to grow white pine stock can and should produce such stock free from blister rust. To do this, the stock must be grown from seed in an area from which all *Ribes nigrum* bushes are absent within a radius of at least one mile, and no Ribes plants of any species present within 1500 feet of the seed beds and transplanted stock. Constructive quarantine policy requires that greater attention be given to this matter by state inspectors and nurserymen so that sanitation of nurseries against white pine blister rust becomes a standard practice throughout the United States. If Ribes are present, nursery inspection cannot insure freedom of the pines from the rust because the disease cannot be detected on white pines until several years after infection has occurred, but inspection can insure absence of Ribes in the protective zone, and thus insure healthy pines. The protective zone around nurseries should be wider than around a woodlot, since loss of a few trees does not occasion commercial damage to a woodlot but would do great harm in nursery stock distributed in uninfected or lightly infected territory. Our common purpose in this matter is to assure healthy stock to the purchaser of white pine, with minimum restriction on the movement of such stock. This also applies to less susceptible Ribes, and is accomplished by fall inspection of the plants, and by shipping them only when dormant, defoliated and dipped in a fungicide of specified strength. Sanitation measures of this character are enforced with respect to Ribes which are permitted shipment out of the infected states under the provisions of Federal Quarantine No. 63.

STATUS OF LOCAL CONTROL WORK

Local control of the blister rust is being successfully accomplished under an eight year cooperative program in New England and New York, and under a 10 year cooperative program in the Inland Empire and Pacific Coast states. In the northeastern states, since 1922, about 5,000,000 acres have been cleared of wild and cultivated Ribes, at a cost averaging 18 cents per acre. Including the experimental control work done prior to 1922, about 6,000,000 acres, or two-thirds of the estimated acreage of the northeastern pine area, have been brought under control. The land owners pay the cost of Ribes eradication, but receive supervisory aid from the state. The United States Department of Agriculture leads the service and educational work required to get pine owners interested and proficient in control. The land must be re-examined for Ribes on an average of once in seven years. However, the cost of re-eradication work is less than the initial cost because Ribes are fewer and smaller. After the initial work is done, well stocked pine stands over 25 years of age commonly remain practically free from Ribes until maturity. The average annual cost of Ribes eradication for blister rust protection in the northeastern states is less than five cents per acre per year, and this is no serious handicap to the profitable growing of white pine under forest management.

The control program in the West is divided into a five year experimental phase, ending in 1930, followed by a five year period of large scale application of control. Progress in development of feasible methods of local control has been more rapid than was anticipated in the schedule of accomplishment outlined in the control program.

Pole stands and mature timber constitute about two-thirds of the acreage cleared of Ribes and the costs of Ribes eradication in such stands have averaged 85 cents per acre. Young timber growth covers about one-fourth of the area and costs of control in this type have averaged $3.17 per acre. The open, brushy, stream type comprises one-twelfth of the total acreage and the average cost of freeing it from Ribes has been $11.46 per acre. Cost of control will vary according to the proportion of these types in the control area. Present results indicate that large tracts can be protected at costs averaging from 10 cents to 25 cents per acre per year.

Control reconnaissance on more than 600,000 acres in the western white pine region shows that 60% of the white pine land is free from Ribes, while 40% bears Ribes and requires systematic crew work to remove them. The more open stands will have to be re-examined at five year intervals. Well-stocked stands apparently remain free from Ribes after the initial eradication work is done until the stand is opened up by logging or fire. It has been found that Ribes seeds remain in the soil for long periods, in viable condition, and there is often a heavy regrowth of Ribes after the ground is exposed by light burning or disturbed by logging.

Data on Ribes ecology indicate clearly that permanent and effective suppression of Ribes can be secured to a very large degree through practicable methods of forest management. Another highly important development in the western control experiments is that *Ribes petiolare* Dougl., a susceptible species growing abundantly in the stream type, is readily and completely killed by spraying the foliage with a solution of sodium chlorate. A light weight forest-fire pump has been modified to give spray pressures of 250 to 300 lbs., and by this means a chemical crew can eradicate Ribes in the stream type at about one-third the cost of pulling the bushes by hand. Further research is being done to make the spray solution fully effective against other species of Ribes, to decrease the cost of spray application and to improve the efficiency of the spraying machinery. These and many other developments give a sound basis for believing that blister rust control in the West will prove to be as practicable and as readily accomplished as it has been found to be in the East.

CHAIRMAN STRONG: Dr. Marlatt explained this morning about the finding of the Mexican fruit worm in Southern Texas last year. Dr. Baker has had charge of the eradication work for the Bureau of Entomology.

PROGRESS OF THE MEXICAN FRUIT WORM ERADICATION

By A. C. BAKER, *Washington, D. C.*

(Withdrawn for publication elsewhere)

CHAIRMAN MONTGOMERY: Dr. Baker's presentation certainly can be regarded as a progress report.

The next paper is on "Pacific Port Inspection." You will recall that at last year's meeting Mr. L. R. Warner presented a paper giving consideration to the inspection methods as followed at Florida ports. We are fortunate in having with us this year Mr. Lee A. Strong, who will give a companion paper, if I may so call it, upon inspection methods as followed at Pacific ports.

PACIFIC PORT INSPECTION

By L. A. STRONG, *Sacramento, Calif.*

(Withdrawn for publication elsewhere)

CHAIRMAN MONTGOMERY: You will all agree with me that that was a splendid presentation.

L. S. MCLAINE: I should like to ask the speaker if the officers of the Federal Horticultural Board are permitted to open passengers' baggage coming from Hawaii.

LEE A. STRONG: The Federal Plant Quarantine Act authorizes the Secretary of Agriculture to make such rules and regulations as may be necessary. He specifically states in the quarantine that the Federal Horticultural Board inspectors have the right to inspect baggage and make such disposition as may be necessary, if it is coming from a foreign port. Unless it is something very recent, the Federal Horticultural Inspectors have no authority to search. The customs officers make the inspection and call it to the attention of the plant inspector, and if it is something that should be inspected the plant quarantine man has the right to search and make arrest.

CHAIRMAN MONTGOMERY: I think Mr. Strong's statement is correct. I know that is our understanding. We are not in possession of direct authority, but fortunately, in Florida, as in California, have that authority extended to us through the customs.

The next paper will be by Mr. Haseman of Columbia, Missouri.

SHALL THE STATION ENTOMOLOGIST ALSO DIRECT THE REGULATORY WORK?

By L. HASEMAN, *Columbia, Mo.*

In those States where the regulatory work of plant inspection and quarantine is still directed by the station entomologist there arises the question whether or not the entomologist should be relieved of the police duties. In most States where both activities were formerly under the same direction, Entomological Commissions, Plant Boards and Boards of Agriculture have taken over the regulatory work, though everywhere in some cases the station entomologist still serves as state entomologist under the commission or board. In such cases, the Agricultural Experiment Station is no longer responsible for the regulatory work though the entomologist continues to serve in the double capacity. In still other cases the two lines of work are separate and distinct and each is directed by a separate official.

The writer has had some 18 years experience with the regulatory work as a regular part of his duties as station entomologist and three years in the double capacity as station entomologist and state entomologist under the State Plant Board. It will be his purpose, therefore, to simply give his views and open the subject to such discussion as others may wish to offer.

Agricultural Colleges and Agricultural Experiment Stations were created for educational and investigational purposes and the enforcement of plant inspection and quarantine regulations is no part of their regular functions. Boards and commissions may be created for this purpose and from an administrative point of view they are the logical bodies to administer plant acts. Strictly speaking, they involve police duties and are, therefore, not a part of College and Station activities. Most Colleges and Stations feel relieved of a burden when the work is transferred to a board or commission.

In practically all States the work is now either completely separated from the College and Station or the entomologist directs it as an activity separate from his other work. Where it is separated it is usually more liberally financed and manned. There seems to be no longer any question about the desirability of divorcing plant inspection from regular college and station work.

On the other hand there is still a difference of opinion among entomologists as to whether or not the station entomologist should continue to direct the regulatory work. There are both advantages and disadvantages in the combined activity. These vary with conditions as found in different states. As far as economy and efficiency to the inspection service are concerned the work should continue under the entomologist's direction. He can train and select his inspectors and bring to bear directly on the inspection problems the results of his investigations and the field activities of his extension staff. He can also at any time use demonstrations or educational methods in place of police force where he finds that is the proper solution of any problem. Regulation without adequate use of educational work usually fails of permanent results. The entomologist in charge of teaching extension and investigation, therefore, has the broader view and more at his disposal which he can bring to bear on any regulatory problem. Without doubt, where the work is adequately financed and manned with trained inspectors so that the entomologist can simply serve as general director, the regulatory work will benefit by his continuing in charge. In such a combination it is the regulatory work which profits most.

Where the entomologist is unable to get adequate help so that he is relieved of all general routine it may require so much of his time that his College and Station work is likely to suffer. Under such conditions he should be relieved of the inspection work. The ideal condition is where he is free to devote his attention primarily to his college and station work and simply serve in an advisory capacity in directing the plant inspection activities. In this way he can unify the entomological work of the state, maintain a general supervision over the different activities and make sure that the regulatory work is effective in preventing further introduction and spread of scourges. In such a case while the two departments may in reality be separate and distinct, still their efforts may be closely coordinated and both strengthened. It is the writer's opinion that in most states the best results may be expected where the regulatory work is administered by a separate Board or Commission and where the entomologist of the Agricultural Experiment Station or the head of the department in the College acts primarily in an advisory capacity.

CHAIRMAN MONTGOMERY: The next paper is by G. G. Becker, San Antonio, Texas. This will be presented by Paul H. Miller.

NON-PEAR ZONES AND BLIGHT ERADICATION

By GEO. G. BECKER, *Former Chief Inspector of the Arkansas State Plant Board*

On the assumption that in the Arkansas Ozarks pear blight as a disease of apple orchards is capable of maintaining itself only through the agency of pear trees an attempt is being made to eradicate the disease by requiring the destruction of pear trees. The results indicate that the disease is being eradicated by this means.

In the apple growing regions of the Arkansas Ozarks commercial pear culture, because of the frost and blight hazard, is not generally considered to be profitable. Such pear trees as occur here are usually in home orchards or else in neglected plantings. It is not surprising, then, that, following the success in the eradication of cedar rust in this region, apple growers demanded the eradication of pear blight by requiring the destruction of pear trees.

Various plant pathologists, especially Dr. J. H. Roberts and Mr. Leslie Pierce of the Bureau of Plant Industry, were consulted on the feasibility of such a program, and the late Dr. J. A. Elliott, as plant pathologist of the Arkansas Experiment Station and as a member of the Arkansas State Plant Board, was, of course, particularly active in planning the details of the work. It was known to the Board at that time that pear blight had, on occasions, been found to winter over on apple but this was considered to be exceptional. On this latter point, however, the writer hastens to say that it is not the purpose of this paper to discuss the technical status of the pear blight organism with reference to its various hosts. As an entomologist and plant quarantine officer it is merely the object of the writer to give the results secured in eradicating pear trees from the vicinity of apple orchards.

In 1922 a pear blight survey was made under the direction of the writer by Mr. Geo. W. Winfrey to determine to what extent pear blight in apple orchards could be traced to pear trees. Mr. Winfrey paid particular attention to orchards in which blight injury was especially severe and to those which were singularly free of the disease. Most of the orchards visited were in Benton County, Arkansas and a few were near Neosho, Mo. The survey indicated that pear blight in apple orchards varied with the nearness and with the number of pear trees which were close enough to spread infection to the orchard. In general, Mr. Winfrey found that pear blight in apple orchards was negligible where there were no pear trees closer than a mile.

In view of these facts the Arkansas State Plant Board on Nov. 11, 1922 promulgated a public notice under the provisions of which it became unlawful to maintain, in certain areas, pear or quince trees infected with pear blight when they were within a mile and a half of an apple orchard. Following the promulgation of the order many pear trees were cut with little delay. In other instances owners tried to keep blight cut out but eventually gave up the task as hopeless. The regulations were first tried out legally in the spring of 1926 when an owner of a small orchard was fined in the circuit court of Benton County for refusing to cut down 85 pear trees which inspectors found to be infected with pear blight. While substantial progress has been made all over the regulated territory there are still quite a few trees standing. In some districts, however, practically all of the pear trees have been cut.

The writer resigned his position with the Arkansas State Plant Board in June 1926 but for some time previous to that it was apparent that, from the standpoint of the orchardist, pear blight in the apple growing region of the Arkansas Ozarks was being eradicated by the destruction of pear trees. It was noticed that there was a definite decrease in the extent of losses being caused by pear blight and that the extent of reduction of these losses was correlated with the extent to which near-by pear trees had been cut. The writer has records on pear blight in 11 orchards in which the disease caused almost annual heavy losses but which have been practically free of blight since near-by pear trees were cut. Many other orchards have, of course, been benefited but dependable records on them are not available.

In the case of a Jonathan orchard near Gravette, Ark., blight caused heavy losses practically every year up until 1922. In 1922 the estimated loss in this orchard was 95% of the blossom clusters because of the ravages of blossom blight. In the fall of 1922 the near-by pear trees were cut down. Though there have been years since that time when blight losses have been severe, blight in this orchard has been either negligible or altogether absent since 1922.

In a large block of Jonathan and Maiden's Blush trees in an orchard near Bentonville the estimated loss caused by blight was 90% of the crop for 1924. At that time pear trees were within 100 yards of this orchard on two sides. Most of the pear trees in the vicinity of the orchard were cut the following winter. Though blight losses were heavy in other parts of Benton County in 1926 the injury in this orchard was negligible. The writer learns through correspondence that blight losses in this orchard were also negligible in 1927.

In a block consisting of four orchards largely planted to Grimes, Jonathan and Maiden's Blush and located near Centerton, Ark., pear blight caused heavy losses practically every year until 1923. Following the promulgation of the pear blight regulations many trees were cut and by 1924 practically all pear trees within a mile of these orchards had been cut down. In 1924 blight was negligible in these orchards and it has remained so ever since.

Through the persistent efforts of Mr. J. F. Fagan, deputy inspector of the Arkansas State Plant Board, to make the Bentonville area a blight free area more work was done around Bentonville in 1925 and 1926 than in any other area of its size under regulation. As eradication progressed blight losses decreased and the writer learns through correspondence with Mr. Fagan that in 1927 the apple orchards of the Bentonville area were singularly free of blight.

During the years that records show blight to have been negligible in the orchards previously discussed in this paper, blight continued to be severe in other localities. In numbers of instances these badly blighted orchards were only ten miles or less from clean orchards. Inspectors noticed that the extent of blight in these check orchards always varied with the nearness and the number of pear trees from which infection might spread to the orchards.

In conclusion it may be stated that, from the practical considerations of the orchardist, abundant and clear-cut evidence in the field will attest to the fact that pear blight is being eradicated from the apple growing regions of the Arkansas Ozarks by the eradication of pear trees and that the progress of eradication is apparently limited only by the extent to which local prejudices and lax law enforcement interfere with or delay the cutting of pear trees.

CHAIRMAN MONTGOMERY: Those of you who have attended the meetings of the Section will remember that we always have some discussion of the Japanese beetle. Mr. Smith is not here to give his paper on the subject, so I shall call on Mr. Fracker, Mr. Rohwer and others to make some statement as to recent developments.

S. B. FRACKER: The spread during the past season is a matter of public record, the amendment to the quarantine having already reached most of the members of this organization. There was little spread to the north, only a few townships in Connecticut and New York being added to the regulated area. More extensive spread occurred north of Harrisburg in Pennsylvania.

As you know, there were also some isolated outbreaks in Maryland, Delaware and south-central Pennsylvania, which are being attacked on the eradication plan, and which have not yet been included within the

Federal quarantined area. The farthest west the beetle was discovered this past season was Gettysburg, Pennsylvania.

S. A. ROHWER: Among the isolated infestations which are being attacked on an eradication basis was the one in the District of Columbia. It had originally been intended to ask that the appropriation for the fiscal year, 1928–1929 be made available as soon as the agricultural bill passed. In consideration of the infestation in Washington City, however, this plan was changed, and an item of $50,000 was included in the urgent deficiency bill which has already passed Congress and has been signed by the President. Part of this sum will be employed in eradication measures in the District of Columbia.

Another interesting feature of the work this season is the recovery of parasites, and it can be stated that the parasite work is developing in a most promising manner.

CHAIRMAN MONTGOMERY: I should like to call on Mr. Burgess at this time for a discussion of the gipsy moth situation.

A. F. BURGESS: In the eastern infested area there was severe defoliation in 1927. The area most severely attacked covered about 150,000 acres. Outside the main infested area there were local spots of heavy infestation which were larger and showed a heavier infestation than in previous years. The maximum recovery of parasites was in 1923, and the defoliation was low that season. Parasite recovery has fallen off since that time, and the infestation has become more serious. Parasite introduction started in 1907.

In addition to parasites, important factors in the control of gipsy moth infestation include winter temperatures, starvation and fungous diseases.

In the barrier zone along Western Vermont, Massachusetts and Connecticut, there was 115% increase in the number of egg masses found this past season, but there has been no increase in the boundaries of the infested area itself.

The flood situation in New England made Christmas tree inspection extremely difficult, and required us to modify our plans as to the field methods of inspection.

CHAIRMAN MONTGOMERY: We will now have the committee reports. I will call on Mr. Strong for the report of the Nominations Committee.

LEE A. STRONG: Having had chairmen the last three years from the extreme east, the extreme west and extreme south, the Committee recommends that we now go north for the Chairman for next year. We, therefore, recommend the name of L. S. McLaine, Ottawa, Canada, as Chairman, and S. B. Fracker as Secretary.

A motion for adoption of report was regularly made, seconded and carried.

The meeting adjourned at 3:45 o'clock.

THE CONTROL OF THE BEEMOTH

By F. B. PADDOCK, *Ames, Iowa*

ABSTRACT

An outline is given of the factors of control for this pest. Climate and parasites are factors of natural control which are much restricted in service. Traps, sanitation, fumigation, repellents, heat and cold are factors of artificial control. Experiments are being conducted which will give more definite information of some of the possibilities of artificial control.

The ravages of the beemoth or waxworm have been known to mankind since the very earliest records. Since that time this insect has slowly but surely spread to every land where bees are kept. The spread of the moth has been slower than the distribution of the honey bee. This retarded spread has not been due to effective natural barriers or to artificial methods employed by beekeepers. Without exception other economic insect pests have been greatly influenced in their ravages by natural limiting factors or by man-developed practices. It is therefore interesting to take an inventory of the factors of control in operation against the beemoth. These agencies can be grouped in two general classes, natural and artificial.

Climate is the first factor of natural control of the beemoth. Just what balance of these factors serves as the check is not understood at present. There are one set of conditions based on altitude. In Austria the beemoth has been a pest from the earliest times but its ravages become less severe in the mountainous regions. Beekeeping is conducted at elevations safely above the range of the moth. In Sweden the moth is common among beekeepers on the coastal area, but disappears in the mountains. Beekeeping is conducted at elevations above the occurrence of the moth. A similar restriction of the moth is known to exist in the United States in parts of Colorado, Wyoming and Montana. In this section the critical elevation seems to be between 4,000 and 5,000 feet.

At this time it is hard to say if humidity is a correlated factor with altitude but under another set of conditions it may well be regarded as a limiting factor. The beemoth was recorded in England at an early date. The spread has been general but slow and never has the moth been an outstanding source of loss to the industry. In Scotland the moth has been known for a long time, it is generally found over the country but is not doing severe damage. Climate in its inclusive meaning must serve as the check on this pest.

Parasites may be regarded as the other agency of natural control of the beemoth. The outstanding feature in this case is that a pest of such antiquity and such general distribution should be so little subject to biological factors of control. The recorded parasites come from three families, three species of *Braconidae*, three species of *Chalcididae* and four species of *Ichneumonidae*. The reported parasites, with one exception, are primarily parasites of other economic pests. Only three of the recorded species are known to occur in the United States and their occurrence has been most sporadic. There is certainly no real control of the beemoth by the agency of parasites.

Reviewing the factors of natural control it is evident that as a relief measure it is of no real benefit. For help in the control of the beemoth it is apparent that man-made practices must be depended on for real success. Development along this line has been very slow and indifferent. In fact through almost 2,000 years the beekeeper has been confronted with the ravages of the moth and his efforts have been of only little real service. What has been done is interesting mostly to obtain a retrospect view of the problem.

Traps for the control of the beemoth were discussed by Collumella as follows: "To this end, a vessel with a narrow neck increasing gradually to a wide mouth, with a light in the neck should be placed under the hive in the evening. The moths gathering from all parts around this light are in that narrow space, scorched and killed." This method of control has been advocated occasionally since that time but seems to be worthless in solving the problem.

Sanitation was also recognized by Collumella as a relief measure when he says "Particular care must be taken to sweep out every caterpillar and to destroy all moths." Butler in 1623 enlarges on sanitation to include the beeyard. He said, "The flying moth breedeth little worms. Rid your hives of these guests. They hide in long grass and weeds." An interesting confusion existed at that time for Butler says, "The maids that sun their clothes to rid their flea, let them take heed how they do it near the beefold, lest they bring in worse enemies than they carried out." English writers continued to recommend the measures of sanitation which surely was an aid when immovable frame hives were used. Warder in 1720 says, "Disturb and shake out all maggots, clean away all trash." A little later it was advised to fill all cracks of the hive with lime for it was known that these aided the moth. In 1819 Wildman advises "Lift up the hive in the morning, kill the moths and also clear away all webs." Later more severe measures were prescribed. Cotton in 1842 says "Turn hive up and cut freely out the whole of such combs as have the grubs in them. Do this in the spring. Prevent the moths by using a small entrance. " As late as 1870 Bevan recommends "Frequently lift up the hive in the morning and kill all you can see. Drive bees into a new hive then cut out and destroy infested combs."

This relief measure failed to hold the moth in check and so more effective means were sought. With the coming of the movable frame hive the weak spot seemed to be the control of the moth outside the colony. By this time the practice was well established of maintaining strong colonies, and Italian bees were becoming fairly common and also progressive beekeepers were using the movable frame hive.

Fumigation was then to displace the sanitation and trap program as it has been recommended up to 1880 when Cooke summarized the control of the moth. "Examine infested hives, collect and burn the larvae. Special hives are of no avail but have strong colonies in movable frame hives. Trap moths and larvae by wooden blocks and cloth. Band around the outside of the hive to trap the moths during the day."

Sulfur or brimstone as it was then called, was the first material considered as a fumigant against the moth. It was recommended for use with honey stored in combs and any empty combs not in use in the hives. The dosage was ¾ pound per 200 cubic feet of space. It was recognized that this treatment was not effective against the eggs so it was recommended to refumigate in ten days. In England it was said by Cawan that "sulfur fumes destroy the eggs of the moth as well as the larvae." This may be accounted for in the light of recommendations of Bonney of Iowa in 1918 when he says "Burning sulfur becomes efficient by adding moisture to the air." His dosage was much higher, being 1 pound per 100 cubic feet. Other recommendations take into account the resistance of eggs to sulfur fumes and advise a refumigation. As late as 1922 sulfur fumigation was considered "as cheap and as effective as any method" in Germany. However, frequent treatments were necessary to effect control. The advantages of sulfur may be listed as follows: It is readily available, is cheap and not dangerous in application. The disadvantages are the uncertainty of results and necessary presence of a source of fire.

Carbon bisulfide was offered as an improved material for fumigation against the moth just prior to 1910. This material had been extensively used against other insects in the years just preceding this date. Its use developed very rapidly and dosage tables were developed by the writer in 1911. The recommendation was 1 ounce of bisulfide for every 4 cubic feet. The advantages of this material are: effective against all stages, reasonable in price, accessible, rapid, no active source of fire. The disadvantage is the outstanding liability of combustion and explosion. In reality its use is considered dangerous in the hands of an ordinary operator. Carbon bisulfide has been recommended in Quebec in 1914 and in France in 1921.

Carbon tetrachloride followed closely on the advent of bisulfide since it overcame part of the recognized serious objections to the use of the latter. Its use was recommended in France in 1912 where its cost was less than bisulfide, slower to evaporate, less smell, no danger to the operator, no danger of fire or explosion and was effective against all stages of the moth. In this country it did not seem to replace bisulfide as it was not readily available and the cost was not satisfactory.

Hydroycanic acid gas was recommended for fumigation against the moth in 1917 by German workers. It was extensively advised in publications where detailed explanation of methods of operation were described. It was offered as an advance over sulfur fumigation. Its use apparently never reached outside of Germany. From our viewpoint the application of this material is recognized as effective but its use is beset only with extreme danger as the gas is so deadly.

Paradichlorobenzene became available next as a fumigant for the moth and was heralded by beekeepers in 1919. This soon became known among beekeepers as "Para" and later as "moth fumigator." Its early use was most extensive throughout the southern sections of the United States. It has been made generally available to beekeepers at a moderate cost but its use has not been as extensive throughout northern sections as was expected. It soon became evident that it was not thoroughly effective under all conditions and in fact no accurate dosage table has been devised for moth fumigation. The writer has now experiments under way to determine the dosage and optimum conditions of temperature and humidity. There is now available a standardized product which will undoubtedly render general use more probable. The gas is five times heavier than air so that it is difficult to confine the gas in high piles of supers containing combs. The gas is very effective when confined and its use is not accompanied with the usual dangers of fire and overcoming the operator. This material should prove popular when its use is properly advised after experimental data is available.

Gobal, a proprietary compound was offered to beekeepers in Germany in 1919 as a material to kill the moth. Its use apparently was not extensive nor of long duration. Zyklon was recommended in 1920 for use by beekeepers in moth control after experiments were conducted by Armbruster. References do not indicate that this material has been used extensively.

Formalin was recommended in 1924 by Whyte for use by British beekeepers in their fight against the moth. He says "for small lots use two ounces in a saucer for 24 hours. Dosage tables have not been devised for this material which may have a definite value in control efforts against the moth.

Calcium cyanide has recently been recognized as an effective fumigant for insect pests and rodents. It has been used by beekeepers for purposes other than the moth. It should prove popular as a material for use against the moth. Experiments are now being conducted to determine the dosage table and the optimum conditions for its use. It is readily available, cheap, no fire danger, but there is need for precaution on the part of the operator.

Carbon tetrachloride in combination with ethyl acetate was recommended in 1926 by Hutson for use against the moth. The material is made of six volumes of tetrachloride and four volumes of ethyl acetate. A partial dosage table has been compiled showing that 3 pounds of the mixture to 100 cubic feet for 24 hours kills all larvae but an exposure of 48 hours is necessary to kill all pupae. This dosage was not effective against the eggs. This material is not effective at temperatures below 60° F. There is no odor after the use of this material and while distribution is not wholly staisfactory yet the price is considered reasonable.

From the foregoing it must be evident that very little is really known about control measures for the beemoth. There is need for extensive work on many possible methods of reducing the ravages by this pest. Some of this work is now under way and it is hoped that effective measures may be made available for the destruction of this ever present pest of the apiary.

Repellents for the control of the moth have received very little consideration from research workers or beekeepers. In 1920 it was reported in Germany that moth injury was less when a hive stood on a sheet of tin than when the usual floor board was used. Another item from Germany suggests the practice of wrapping up combs in newspaper to protect them from the moth. A very interesting observation comes from Germany that tomato leaves, whether green or dried, are very effective in keeping away moths.

Superheating is a possible type of control for the moth. This has apparently received no attention from workers on the moth although heat has been effective against other pests whose work of destruction is the same in general. It is known that many insects succumb to high temperatures after a long exposure. The relatively low melting point of wax or the combs has probably discouraged effort along this line of control.

Cold has long been recognized as a factor of control for the moth. But no experimental work has been done to determine the effective temperature. In 1905 it was reported that 10 F° would kill larvae but nothing further has been given out.

THE RELATION OF FLIES AND FLY SPRAYS TO MILK PRODUCTION

By Stanley B. Freeborn, *Associate Professor of Entomology*, Wm. M. Regan, *Professor of Animal Husbandry* and Arthur H. Folger, *i/c Advanced Registry*,
University of California Agricultural Experiment Station,
Davis, California

Abstract

1. This paper presents data gathered to check results secured during the summer of 1925 and to attempt to ascertain the causes for losses in production that resulted from spraying.

2. Exposing high producing cows to an exceedingly heavy infestation of house flies did not result in lowered production.

3. In the absence of flies, sponging with water had no effect on production, spraying, with water caused a loss of 5.4 per cent, with pine tar-creosote a loss of 6.9 per cent, and with oil a 9.7 per cent loss.

4. During the last two weeks of spraying the loss in production was 12.5 per cent for the pine tar-creosote and 22.8 per cent for the oil sprayed group.

5. The body temperature was consistently higher, sometimes as much as 3 degrees F., for the oil sprayed group than for the controls. The respiration rate of the former averaged 40 per cent higher than that of the latter.

That high producing dairy cows exposed to a heavy infestation of flies suffered a slight loss in production and that the application of commercial fly spray with a base of petroleum oil caused a further reduction were the conclusions drawn from an experiment conducted by the authors in the summer of 1925 at the University of California Experiment Station, College of Agriculture, Davis, and reported in the Journal of Economic Entomology *18*:779–790.

The loss attributable wholly to flies in this previous trial was as follows: horn flies, 1.4%; house flies, 3.33%; stable flies, 9.26%. When a bland, non-toxic oil was applied in the presence of stable flies, the loss in production was 21.0%; in the presence of horn flies, it was 13.1%. Pyrethrum extracted in a light oil was added to the spray described above and applied in the absence of flies. The resulting loss in production was 4.3%; when stable flies were present, it was 12.4%.

During 1926 an attempt was made to ascertain the reasons for these losses and to check the results of the previous season. Eight cows of good production and approximately in the same period of lactation were confined in pairs in screened stalls.

Group A, the controls, was left untreated throughout the experiment, no flies being allowed in their stall. Group B was given a rest of one week after entering the stall. During the second week, they were sprayed with water daily to ascertain the effect of the mere act of spraying. During the following two weeks, a light application of non-toxic, colorless petroleum oil was made daily. During the next two weeks this spraying was continued, and from 5,000 to 10,000 house flies were liberated in the stall each day, the flies up to this time having been excluded. There followed then a period of two weeks without spraying but with the daily addition of flies. During the last week of the experiment, the flies were excluded and the cows kept under normal conditions.

Group C was treated exactly as Group B, except that a pine tar-creosote spray was substituted for the oil spray of Group B during the periods in which the cows were sprayed.

Group D, after the first normal period of seven days, was sponged with water daily for a week as an alternative to the water spray received by Groups B and C. During the next six weeks, from 5,000 to 10,000 house flies were liberated each day in the stall. All flies were excluded during the closing week of the experiment.

The curve of decrease shown by the controls was taken as the normal expectancy for all cows, inasmuch as all were in approximately the same stage of lactation. This curve was then superimposed on the actual production graph of the test animals and their amount of increase or decrease above or below their expectancy was computed.

SPRAYING VERSUS SPONGING. Because of the possibility that the mere act of spraying rather than the effect of any particular spray used might cause the cows to become nervous and thus bring about a loss in production, two groups, B and C, were sprayed with tap water, one group, D. was sponged, and the controls, A, were left untreated. As shown in Figure 1, the sprayed cows, B and C, fell 5.36 and 5.52%, respectively, below their expectancy, while the sponged cows remained .55% above, and the controls showed no tendency to fall. These figures indicate that spraying, even with water, has a tendency to lower milk production at least temporarily. Although there was no upward trend during the one week of this trial, it is very probable that after a longer period the animals would have become accustomed to the strangeness of the procedure and regained their normal production.

SPRAYING WITH REPELLENTS. The two sprays used in the present trials were, (1) a bland, non-toxic, colorless and tasteless oil of eastern origin and (2) a pine tar-creosote spray. In the 1925 trials, the bland petroleum oil used was of western origin having a specific gravity of .8762, flash point of 310, and Saybolt viscosity of 105. To determine whether the physical characteristics or toxic end products were responsible for the lowered production during the first year's trials, the oil used in 1926 was of eastern origin, having a specific gravity of .8363, flash point of 340, and Saybolt viscosity of 68.

The pine tar-creosote spray was a combination of commercial creosote and pine tar emulsified with sodium hydroxide to form a stock solution to be diluted with water. Two different stock solutions were prepared. The first was composed of 100 cc. of creosote and 400 cc. of pine tar, to which 40 grams of sodium hydroxide were added in a liter of water and thoroughly mixed. This was then added to tap water, due allowance being made for the liter of water already added, to make a 1, 2, and 3 per cent spray. The other stock solution was made by combining equal parts of pine tar and creosote, after which the same method of emulsifying and diluting was followed.

TABLE 1

	After Spraying %	24 Hours Later %	Average Efficiency %
Eastern White Oil	91.93	74.55	83.24
Creosote 100			
Pine Tar 400			
1%	69.31	61.83	65.57
2%	75.65	74.74	75.69
3%	82.22	75.21	78.71
Creosote 250			
Pine Tar 250			
1%	83.34	76.71	80.02
2%	74.02	76.69	75.35
3%	82.66	79.98	81.32

These sprays, together with the oil spray, were then applied to animals in quantities just sufficient to insure coverage. During the first ten minutes after each application the number of flies that alighted on one side of each cow was taken. Control animals were observed at the same time and from these comparative counts the percentage of efficiency of each spray was computed. Twenty-four hours later, the same cows were observed again and a comparison made with a control. The two averages, i.e., one immediately after spraying and another 24 hours later, were combined to give a single average that would express the efficiency after a 24 hour period.

A study of Table 1 shows that the oil spray was in a small degree the most efficacious repellent. Furthermore the spray containing equal parts of creosote and pine tar was more satisfactory than that having more pine tar than creosote. As a result of these trials, it was decided to use the 3% dilution of the former.

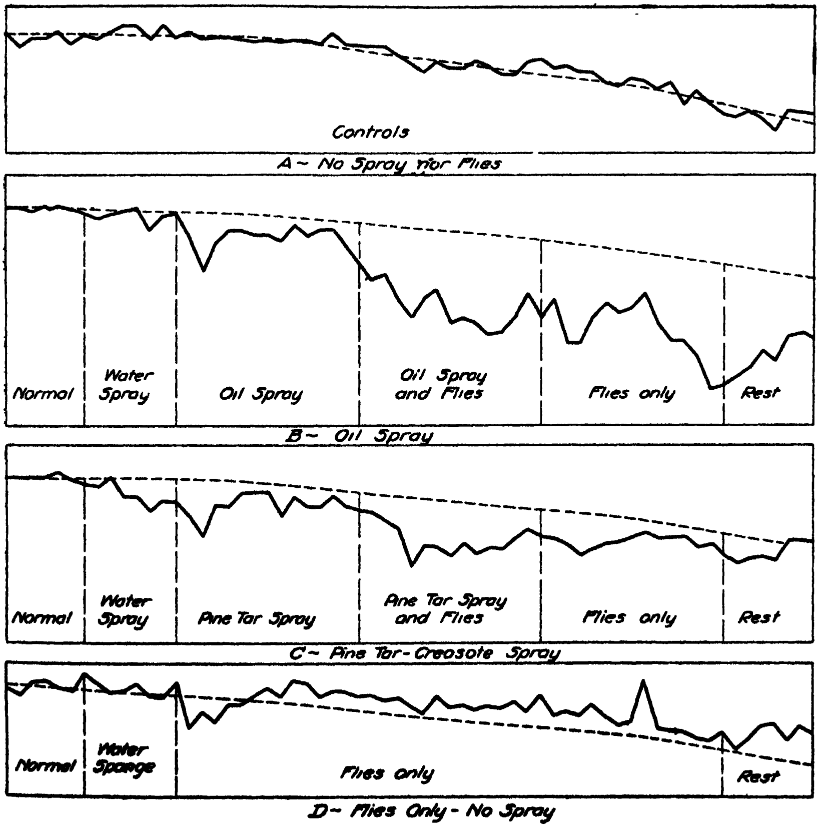

Fig. 31.—Chart of milk production. Dotted line represents expectancy.

The physical appearance of the sprayed animals (dry stock was used in these trials) was very satisfactory. Neither spray caused the animals to pick up any unusual amount of dust or debris, and the condition of the skin showed no ill effects.

Any spray that will repel more than 80 per cent of the flies over a 24 hour period without injuring the coat or skin and without tainting the milk is decidedly a valuable adjunct, *providing* its application does not decrease the milk production.

The next step then was to measure the effect of this spraying in terms of milk production. Group B was sprayed once daily with the white oil in quantities varying from 250 cc. for a small Jersey to 500 cc. for a large Holstein. A pressure sprayer was used and every effort made to get complete coverage without excess anywhere. As much spray is necessarily wasted in spraying the legs, belly and head, no animal received the whole amount given above.

That both the oil and creosote sprays had a detrimental effect on production is evident from a comparison with the water spray. At the end of two weeks, the cows sprayed with oil had fallen 9.74% below their expectancy and those sprayed with pine tar-creosote, 6.93% as contrasted with 5.52 % during the preceding week when a water spray was used.

As mentioned before, from 5,000 to 15,000 house flies were then liberated daily in both of these stalls and the spraying was continued for two weeks. Stall D, which received approximately the same number of flies as the two stalls containing sprayed cattle, offers an interesting comparison. During this period, the cows subjected to flies but not given any protection or damage by fly sprays had exceeded their expectancy, as determined by the performance of the controls, by 1.8%. This favorable balance was maintained throughout the experiment.

The flies used in this experiment were all house flies (*Musca domestica*) with a very small percentage of *Muscina stabulans* and *Eristalis tenax*. These were easily trapped in large cylindrical cages baited with 24 hour cultures of bran, molasses, and powdered yeast. In the 1925 trials, house flies were shown to be of some slight importance from the standpoint of lowered milk production but the percentage determined,—3.3.—was scarcely larger than the probable error. It should be added at this point also that one of the control animals fell off in production in an abnormal manner, which consequently lowered the average expectancy. For this reason, the slight reduction, if any, caused by fly infestations did not become evident, and the losses from spraying were minimized. With these facts in mind, it is safe to assume that under the conditions of the trials, no damages by fly infestation were recorded, all losses being chargeable to spraying alone.

Thus, the loss from spraying for the second period was 12.5% for the pine tar-creosote and 22.81 % for the oil sprayed group. During this

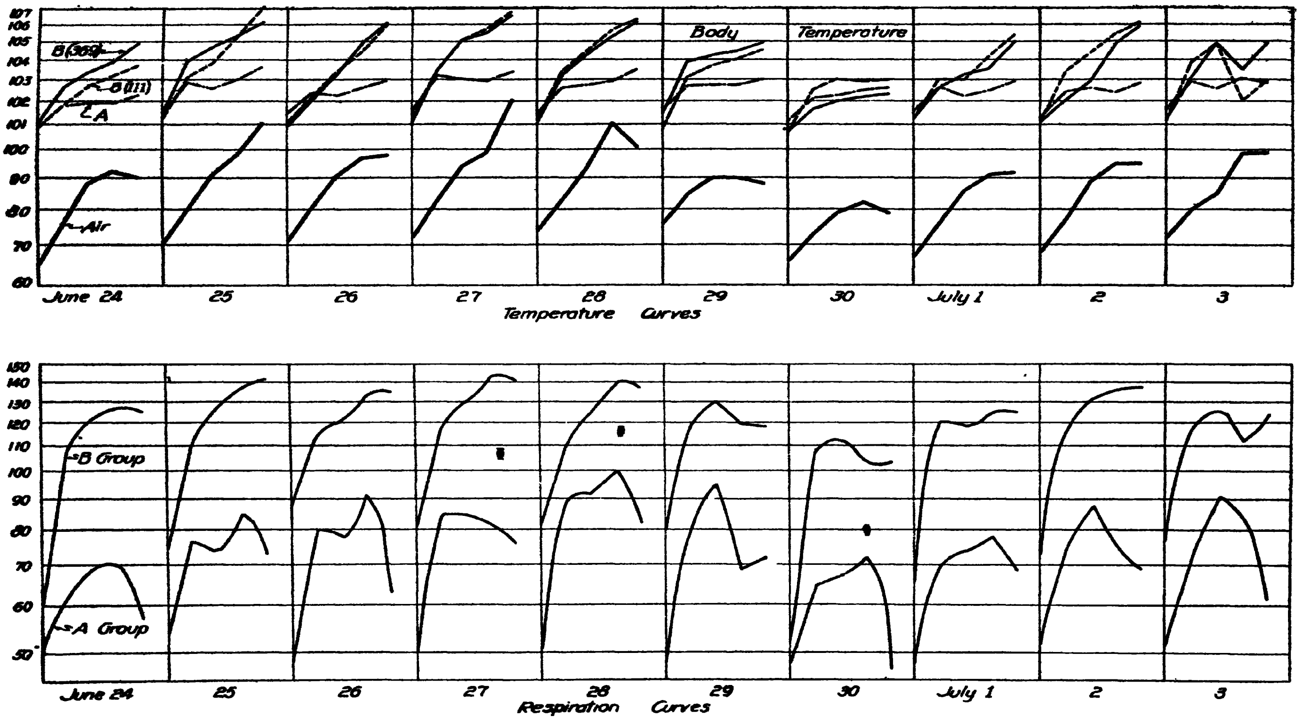

Fig. 32.—Curve of body temperatures and respiration rates of control (A) and oil sprayed group (B). Mark X in the respiration curves denotes high point pine tar-creosote sprayed animals. Note curves for June 30, a cool day and drop on July 3 when sprayed animals were washed with soap and water.

period, several days of high atmospheric temperature were recorded, and the clinical appearances of the animals sprayed with oil were such that it was thought necessary to refrain from the further spraying of one of the cows, in order to prevent a pneumonic complication. Fig. 32 shows in graphic form the relation between the body temperatures of the two cows sprayed with white oil, the average of the unsprayed controls, and the atmospheric temperature. As would be expected, the curve of the respiration duplicates the curves of body temperatures. These are shown directly below in Figure 32 for the same days, the upper line representing the respiration of the oil sprayed animals and the lower that of the normal controls. A study of these curves makes it evident that while the body temperature and respiration of normal cows are but slightly affected by increases in air temperature, the body temperature and respiration of the oil-sprayed cows show a striking correlation with the temperature of the air. The body temperatures of the cows were taken for 25 days at two hour intervals during ten daylight hours and were compared with the readings from a recording thermometer kept in the occupied shed. The result of studies of these data showed a correlation of .6841 ±.019 between the air temperature and the body temperature of the controls. On the other hand, a similar study of the body temperature of the oil sprayed animals and the air temperature shows the striking and almost perfect correlation of .95679 ±.00387. Similar studies were also made with both the controls and oil sprayed cattle and with both wet bulb readings and "effective" temperature readings. The latter were determined by bisecting the angle on a psychrometric chart between the dry and wet bulb readings. Both of these studies failed to yield the striking results of the correlation with the air temperature. A possible explanation of this lack of correlation may be found in the fact that under Sacramento Valley conditions the humidity in summer is inversely proportional to the dry bulb reading, and as the temperature is constantly high, the "effective temperature" is merely a dry bulb reading modified in its severity by a slight degree of humidity.

The two cows being sprayed with oil reacted in an entirely different, although to one who knew the cows' records, not an entirely unexpected manner. The Holstein, soon after the advent of the spraying procedures, began to decrease rapidly in milk production, and although her temperature and respiration indicated that she was in an abnormal condition, her general clinical picture was not that of distress. The Jersey, on the other hand, made a valiant attempt to produce the normal amount of milk, and although she fell far short of the mark, her decrease was not precipitous as in the case of the Holstein. The result of this effort, however, showed in her physical appearance which was that of extreme weakness. On the advice of the University veterinarians spraying was discontinued and the animal washed repeatedly in order to prevent serious illness. The clinical pictures of these two animals led to the belief that production might be a factor in the complex. To determine this point, a group of steers was sprayed heavily and their body temperatures and respiration rate were taken every two hours. This group of non-producing stock showed no increase in either of these measurements.

Unfortunately, no temperature records were taken for the group of cows sprayed with pine tar-creosote. However, their respiration was noted on some of the same days shown in the graph of the oil sprayed cows, and their high peak is marked with an X. With this fragmentary evidence, which is, at most only an indication, it mav be assumed that they, too, reacted to the spray in an unfavorable manner as is shown by their 12.5% loss in production during the second spray period. Their recovery was relatively rapid, however, when compared to the oil sprayed animals.

One conclusion that might be drawn from this experiment is that the oil forms an impermeable layer over the surface of the body, preventing evaporation and the interchange of gases and thus inevitably forces up the body temperature and increases respiration. The pine tar-creosote spray, while not producing similar results immediately might do so in time. The evaporation of this spray on a clean glass slide leaves a thin viscid film, which through daily additions would soon produce a covering fully as effective as that formed by the oil. An animal that is not producing to capacity would probably be able to withstand the added labor of increased respiration in compensating for the impaired function of the skin. A high producing cow covered with an impermeable layer of material, however, even though she be standing idle in the stall is working under a handicap comparable to that of a draft horse which is expected to pull a capacity load on a hot day, muffled from head to foot in blankets.

As a result of these two years of investigation it is evident that the loss to dairy production caused by flies is sometimes greatly overestimated and that often greater damage to the cows results from the spray than from the flies.

PETROLEUM OIL AS A CARRIER FOR NICOTINE[1]

By E. R. de Ong

Abstract

The value of petroleum oil as a spray is not confined to its insecticidal value alone but includes a potential value as a carrier for other and more active chemicals which may act as insecticides and fungicides or perform functions which we may not now recognize.

Experiments performed on the Brown Apricot Scale have shown a material increase in toxicity by the addition of small amounts of nicotine to oils, especially kerosene.

The potential value of petroleum oil as an insecticide for use on plants has long been recognized but its general application both as a dormant and foliage spray was made possible only by the use of the more highly refined fractions containing a minimum of unsaturated hydrocarbons. The establishment of this practice has removed petroleum oil from the list of doubtful reagents to one of recognized value. This change in the status of petroleum oil opens the way for manifold uses not alone as an insecticide but from the physiological standpoint, for example, in retarding excessive transpiration of moisture. Another and perhaps more important field is in combination with other chemicals which may give an increased insecticidal value or as a carrier for fungicides, herbicides and even disinfectants.

The work with nicotine sprays in the past has been largely under the limitation of water as a carrier. But water will not "wet" the surface of a leaf as will oil, nor penetrate the insect's tracheal system; nor will it dissolve the waxy covering of armoured scales or the secretion of mealy bugs and woolly aphis. Hence the present study of attempting to increase the toxicity of both nicotine and oil by using them together.

Combinations of oil and nicotine have been used in the past but on account of the dangerous types of oils then available, the use was generally restricted to dormant trees or with a frank recognition of the fact that the risk from the use of oil was less than that of allowing some pest to go unchecked. We have now reached the opposite extreme in that the oils used are so inert as to lower their insecticidal nature, but their potential value as wax solvents, penetrants of minute apertures or their wetting powers are retained. The next logical step then is to combine the native values of the refined oil with the toxicity of nicotine or the fungicidal value of copper or other materials and thus improve the efficiency of each.

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[1] This work was begun in the University of California Agricultural Experiment Station and continued as a cooperative study with R. B. Arnold, Research Chemist of the Tobacco By-Products & Chemical Corporation.

One advantage which may be expected from such combinations is that volatile oils, safer to use on foliage than more viscous ones, may act as a carrier for nicotine just as well as those of a less volatile type and thus efficiency as an insecticide may be maintained and some of the difficulties eliminated which have arisen from heavy viscous oils. The volatile oils are also cheaper than the more viscous types.

Considerable experimentation has been completed on the mealy bug (*Pseudococcus gahani* Green) with oil and nicotine combinations, but as yet the work is not sufficiently complete to warrant publishing. The results thus far indicate that an oil of the type of No. 2 is the most promising. The oil alone however, is not sufficiently active in itself but we are now approaching satisfactory control with some of the nicotine combinations.

TABLE 1. COMPARATIVE TOXICITY OF OIL AND OIL AND NICOTINE ON BROWN APRICOT SCALE (*Lecanium corni* Bouche)

Material Used Oil	Emulsion %	Mortality %	Range %	Summary of Mortality %
No. I[1]	1	80.1	74.3–85.9	Average percentage of oil alone 79.5
No. I	2	78.3	56.3–93.8	
No. I with .01 Free Nicotine[2]	1	92.4	91.9–93.0	Average percentage of oil and nicotine 92.4
No. I with .02% Free Nicotine	2	92.5	81.3–98.9	
No. II	1	92.8	92.1–93.5	Average percentage of oil alone 94.8
No. II	2	96.8	94.9–99.3	
No. II with .01% Free Nicotine	1	94.2	90.9–97.6	Average percentage of oil and nicotine 96.4
No. II with .02% Free Nicotine	2	98.6	92.3–100	
No. III	1	90.2	88.9–91.6	Average percentage of oil alone 91.7
No. III	2	93.2	88.2–96.5	
No. III with .01% Free Nicotine	1	94.9	94.5–95.4	Average percentage of oil and nicotine 95.4
No. III with .02% Free Nicotine				
No. IV	1	89.3	88.5–90.1	Average percentage of oil alone 88.8
No. IV	2	88.3	74.0–96.7	
No. IV with .01% Free Nicotine	1	92.1	98.1–92.5	Average percentage of oil and nicotine 93.6
No. IV with .02% Free Nicotine	2	95.1	82.8–100	
Control		66.6		

[1] Specifications of Oils used given in Table 2.

[2] A commercial grade of Nicotine, 95% purity.

TABLE 2. PROPERTIES OF OILS USED

No.	Gravity B	Flash Point F	Fire Point F	Viscosity at 100 F	Color	Sulfur %	Unsulfonated Residue	Acidity
			Kerosene					
I...	35.9	124CT	——	375	——	——	81	——
			Light Lubricating Oils					
II..	35.0	——	——	55–60	——	——	80	——
III.	28–31	280–	——	70–80	25	.015	98	.0
IV.	29.8	320	360	106	25	.006	98	.0

The most complete data we have is on the Brown Apricot Scale (*Lecanium corni* Bouche), as given in Table 1. A comparison of the summary of mortalities will show a decided advantage of oil-nicotine combinations over oil alone. The difference between the types of oils themselves is not as great as that between oil and oil-nicotine combinations. It will also be seen that nicotine and kerosene may be just about as effective as a lubricating oil and nicotine. The cost of kerosene would, however, be about one-fourth that of the heavier oil, while the latter would be much less safe on foliage. It will also be noted that oil No.IV, with a viscosity of 100–110 sec. is less effective than No. 11, with a viscosity of 50–60 seconds.

While the nicotine-oil combinations do not seem to offer much advantage for dormant spraying, the use of these combinations for foliage applications appears very promising.

NOTES ON OIL-EMULSIONS WITH SPECIAL REFERENCE TO APHIS ON APPLE

By S. W. FROST[1]

In 1924 some investigations were started with cold-mixed oil emulsions but it was found necessary to discontinue this work. A few figures were gathered which seem worthy of mention. They show that a degree of control of the rosy aphis, *Anuraphis roseus* Baker, can be obtained with a delayed-dormant application of oil.

The emulsions were all mixed in the same manner using one pound of Calcium caseinate, three gallons of engine oil, and one hundred gallons of water. (In preparing large quantities, it was found convenient to mix the stock solution in the spray tank using two guns to keep the material thoroughly agitated.) Several brands of engine oil, donated by the Sinclair Refining Company and the Texas Company were tried. Kerosene was used as a very volatile and light oil while Sunoco was used as an oil of high viscosity.

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[1] Published by permission of the Director of the Agricultural Experiment Station as a part of Project No. 696. Contribution from the Department of Zoology and Entomology. Technical paper No. 426.

One series of tests was conducted at the laboratory. Infested branches were gathered from an apple orchard on April 9th. These were held in a clamp and sprayed first from one side, then from the other, using a good hand sprayer with a "Vermorel nozzle," and 50 pounds pressure. When spraying the nozzle was held three or four feet from the branches. Two tests were conducted: one giving the branches a very light application, allowing only the edges of the mist to strike the branch, the other a drenching application. The aphid counts were made the following day while the red-spider counts were not made until a week later, when the check branches showed that the eggs were hatching.

RED-SPIDER COUNTS

Material	Analysis of Oil			Lightly	Sprayed
	Base	Viscosity[2]	Specific Gravity	Number Spiders	% Kill
Water	——	——	——	1299	6.5
Kerosene	?	about 10 sec.	?	1659	9.7
Miner's Neutral[1]	Paraffine	50 sec.	34½–35½	1232	69.5
Corvus[1]	Paraffine	70 sec.	28–30	1827	70.1
Alweather[1]	Asphaltum	100 sec.	21–22	866	65.5
Nabob[1]	Asphaltum	200 sec.	20–25	742	76.0
Coss[1]	Asphaltum	200 sec.	19.7–20.7	647	60.6
Sunoco[1] 1–20	?	about 2000 sec.	?	——	——

[1] Trade names.

[2] Saybolt at 100° F.

APHIS COUNTS

Material[5]	Lightly Sprayed		Drenching Spray	
	Number Aphids	% Dead	Number Aphids	% Dead
Water	218	.4	158	1.2
Kerosene	98	4.1	177	41.4
Miner's Neutral	72	1.3	107	98.2
Corvus	——	——	173	100.00
Alweather	200	7.5	70	100.00
Nabob	67	7.4	157	99.4
Coss	175	20.0	181	100.00
Sunoco 1–20	170	44.7	137	100.00

[5] Same analysis as in preceding table.

A second series of tests was conducted in an apple orchard. Four blocks of trees, including at least 100 trees in each block, were sprayed April 13th with different cold-mix emulsions using the same formula as was used in the previous tests. Counts were made on June 1st of leaf clusters infested by rosy-aphis, with the following results:

Aphis Counts, Pitzer Orchard, 1925

Material[1]	Total No. Clusters	Number Infested Clusters	% Infested Clusters
Check	520	71	13.6
Nabob	1029	29	2.8
Kerosene	1000	25	2.4
Lime Sulphur	1070	70	6.5

[1] A 3% emulsion with Calcium caseinate was used in each case.

The following year a second test was conducted in another orchard, giving similar results.* Sunoco oil was used in the Delayed dormant application at the rate of 1–20, applying it with 200 pounds pressure. Immediately after spraying branches were cut from the trees and all buds which had not been wet by the spray were removed. In this way it was certain that every bud and all the branch was thoroughly covered with oil. Under these conditions a count was made the following day showing a 100% kill. But, when branches were selected at random from the same orchard sprayed in the same manner the count showed only a 38.3% kill. It is very evident therefore that even under the best of spraying conditions and greatest of care, only a comparatively small percentage of aphis can be killed. Drenching on the other hand certainly gives a high percentage of kill.

Further tests of immunity from burning, where cold mixed emulsions were used, were tried on two year old and twelve year old trees. Burning was in no case noted even where such oils were applied as late as June. Some of the tests are summarized in the following table:

Tests of Oil Emulsions to Determine Immunity from Burning

Emulsified with Calcium Caseinate[1]	% of Oil	Date of Application	Age of Trees	Results
Kerosene	1½	May 5	2yrs.	no burning
Kerosene	3	May 5	2 yrs.	“ “
Kerosene	3	May 6	12 yrs.	“ “
Kerosene	3	May 6	12 yrs.	“ “
Red Eng. Oil	3	May 6	12 yrs.	“ “
Red Eng. Oil	3	May 6	12 yrs.	“ “
Red Eng. Oil	3	May 6	12 yrs.	“ “
Red Eng. Oil	1½	May 6	12 yrs.	“ “

[1] All emulsion made with one pound Calcium caseinate and 100 gallons of water, with oil sufficient to make the desired percentage.

CODLING MOTH BANDING MATERIALS

By B. A. PORTER and R. F. SAZAMA,
United States Bureau of Entomology, Vincennes, Ind.

ABSTRACT

Preliminary tests of several materials for codling moth banding are here reported. The results indicate that corrugated paper may have a practical value as a banding material, and that tarred paper, corrugated paper, and a tough crepe paper appear to be more effective than burlap. There is need of further tests of different materials, as well as a study of the reactions and behavior of the mature larvae while in search of cocooning quarters.

Because of the present spray residue problem, a renewed interest has developed in mechanical means of reducing codling moth population to a point where a shortening of the spray schedule may be possible. Entomologists who are wrestling with this problem may be interested in the following summary of preliminary experiments which were made in Indiana during the fall of 1926 with several materials which have been suggested for this purpose.

This work was carried on in a block of Winesap trees approximately 25 years old. The trees were fairly uniform in size, bore a heavy and uniform crop of fruit, and the worm infestation was severe. The different types of bands were so placed that the influence of the packing shed, a few hundred yards away, would be approximately equal on all groups. Before the trees were banded, the trunks and larger branches were scraped. The bands were put on September 3rd and 4th, and were examined November 2nd and 3rd. During this period none of the larvae transformed, so that repeated examinations were unnecessary.

MATERIALS USED

The following materials were tested:

BURLAP. This is the present standard material for most sections. The burlap used was about a 9-ounce weight, and it was used triple thickness, six inches wide.

TARRED PAPER. Flint[1] reported in 1917 that a tarred building paper was more effective than burlap in trapping the worms, and has since accumulated further evidence in confirmation of this report. In the tests here described, a cheap, light weight roofing paper was used, in strips six inches wide.

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[1] Flint, W. P. 1918. The Use of Tarred Paper Bands for Trapping the Larvae of the Codling-Moth. Transactions of the Illinois State Horticultural Society for 1917, Vol. 51, n.s., p. 174–177.

CORRUGATED PAPER. The grower in whose orchard this work was done had used strips of corrugated paper with considerable success. In these tests, double faced corrugated paper was used in strips three inches and six inches wide, cut across the corrugations.

CREPE PAPER. This grower has also used for banding purposes a tough, heavy, crepe paper of the type used in wrapping automobile tires and rolls of wire, and for lining barrels. This paper is double, the two layers being cemented together with some black tar-like substance. Our tests did not include this material, but at the time when the other bands were examined, it looked so promising that records were secured from an adjacent row which the grower had banded. These bands were in place five days before ours were, but the trees had not been scraped. This undoubtedly reduced the efficiency of the bands more than enough to offset the advantage gained by the additional five days that the bands were in place.

At the time of examination, several of the corrugated paper bands had been torn open by birds in search of worms, so the figures are not complete, although they represent very nearly the total number caught.

The number of worms trapped by the different types of bands is summarized in the following table:

CODLING MOTH BAND RECORDS—SUMMARY

Mitchell, Ind., 1926

Band	Number of Trees	Number of Worms	Average per Band	Remarks
Burlap, 3 thicknesses, 6 inches wide..	20	1753	87.6	
Roofing paper, 6 inches wide...............	20	2667	133.4	
Corrugated paper, 3 inches wide........	10	2669	266.9	One band slightly torn, 2 badly torn by birds.
Corrugated paper, 6 inches wide........	10	3233	323.3	Three bands slightly torn 2 badly torn by birds.
Crepe paper, 3 inches wide...............	20	2052	102.6	Put on by owner of orchard 5 days before the rest of bands; trees not scraped.

DISCUSSION

A few points of interest are suggested by these results.

Burlap, which is probably the most widely recommended material for codling moth banding, caught the smallest number of worms. This agrees with the results obtained by Flint, who found that burlap bands trapped only about one-half as many worms as tarred building paper, and also agrees with the experience of the grower in whose orchard the work was done, that burlap was the least effective of the materials used.

About 90% of the worms trapped in the corrugated paper bands go into the corrugations, which necessitates replacing the bands at each examination. The bands which have been removed should then be destroyed, or treated by heat or by some other method, to kill the larvae and pupae, in which case they could be used again. It has been suggested that after removal from the tree, these bands could be placed in tightly screened rooms to permit the emergence of parasites and their return to the orchard.

The corrugated paper used in the tests was double-faced. Single-faced material is cheaper and is easier to handle, being more flexible. If used with the corrugations next to the tree, it might be as effective as the double-faced material.

If bought new, and destroyed at each examination, corrugated paper would be considerably more expensive than the other materials, but a moderate increase in the efficiency of the bands might justify an additional expense. The grower in whose orchard this work was done used waste trimmings which he obtained from a corrugated paper factory, in strips one and one-half to four inches wide, at a rather low cost. He also used this material rather extensively in his packing shed, around posts and along the walls, to trap worms which emerged from cull fruit.

In wet weather the corrugated paper absorbs moisture and has a tendency to swell, but if tacked securely in place, it does not fall apart, and appears to lose none of its effectiveness. Whether corrugated paper would be practical for extensive use in commercial orchards can be determined only by actual experience.

A possible explanation of the apparently greater efficiency of the tarred paper and the crepe paper as compared with burlap seems to be the fact that these papers are not penetrated by light, whereas ordinary burlap allows the passage of some light. As was indicated by experiments which Siegler and Plank[2] conducted with white and black bands, it seems probable that the larvae are in search of the darkest available crevices for cocooning quarters. Further experiments are needed with the materials mentioned in this paper, as well as with a number of others which might be of value.

These results suggest the desirability of an intimate study of the behavior and reactions of the larvae after leaving the fruit, to ascertain the various factors which influence the selection of cocooning quarters—darkness, different types of surface, and so on. It may be found that the reactions of hibernating larvae are different from those of larvae which transform the same season and need protection for a much shorter period.

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[2] Siegler, E. H., and Plank, H. K. 1921. Life History of the Codling Moth in the Grand Valley of Colorado. U. S. D. A. Bulletin 932.

If the efficiency of banding and similar mechanical means of codling moth control can be increased, such measures will be more generally adopted, and will aid materially in the solution of the spray residue problem, as well as in codling moth control in general.

Scientific Notes

The Use of Arsenicals in French Vineyards. We all know that, while the use of arsenical poisons has been tolerated to a slight extent in the vineyards of France, it has not been officially permitted. However, the Minister of Agriculture issued an order on February 25th, last, permitting the employment of arsenicals in vineyards between the date of the vintage and the time when the grapes begin to darken the next season. That leaves a long period in which the grape vines may be sprayed with arsenicals. This item is contained in a letter from the Minister of Agriculture to the Permanent Secretary of the Academy of Agriculture of France, published in the Comptes Rendus of the Academy of Agriculture of France (meeting of the 7th of March).

L. O. HOWARD

Preliminary Tests of Ozone as an Insecticide. Experiments on June 29, 1926, with house flies, honeybees, flea beetles, aphids, house fly maggots and meal worms, exposed in a dessicator to a continuous flow of ozone in air, at a concentration of 4 mgs. per litre, showed decided lethal action against the adult insects in exposures ranging from twenty-five seconds to five minutes. The action of ozone on the larvae was undetermined, due to factors which interfered with a correct interpretation of the data. It is planned to continue these experiments with the idea of determining the adaptability of ozone treatments to the control of stored product pests.

E. N. CORY AND H. B. MCDONNELL

A Note Regarding Temperature Curves. Since the appearance of my paper on variable temperatures (J. Econ. Ent. 20:769–782) Dr. V. E. Shelford has called to my attention a paper by Matisse (Action de la Chaleur et du Friod sur l'Activite des Etres Vivantes, 556 p. Paris, Emile Larose 1919) in which he used a three dimensioned diagram for showing the relations between time and temperature and the rate of movement of certain lower organisms.

His figure differs from the one in my article in that the highest rate comes near the moment of exposure to high temperature and the rate decreases exponentially with time. In the case of CO_2 production the rate increased for several hours, and then decreased.

The equation found by Matisse for the relation of temperature to rate of movement seems of fundamental importance. It is, in its simplest form

$$v = e^{-\frac{A}{\theta}}(\lambda - \mu\theta)$$

Where v = velocity
e = base of natural logarithms = 2.71828
θ = temperature above an arbitrary zero for the particular reaction.
A, λ, μ are arbitrary constants, determined from the data.

For the use of this curve the reader must refer to the original memoir, as the mathematics of fitting are too long for reproduction here.

WILLIAM C. COOK, *Montana Experiment Station, Boseman, Montana*

Naphthalene Control of Red Spider and other Insects on Miscellaneous Crops in the U. S. Department of Agriculture Greenhouses. Red Spider is particularly difficult to control on strawberries under glass in winter because the foliage lies close to the ground. W. H. White of the Bureau of Entomology suggested the use of naphthalene vapor as recommended by Hartzell,[1] i. e., one and one-half ounces per 1,000 cubic feet evaporated over a period of six hours in a humidity of 80% and a temperature of 70°F. Four night fumigations at one to several day intervals entirely controlled the red spider, killing eggs as well as adults but, as noted below, the fumigations were above the recommended strength. In addition, ants above ground were killed and no more appeared for about two weeks; apparently the fumigant acted as a repellent. White fly adults, but not eggs, aphids above ground and some, but not all, mealy bugs were killed.

Fumigation was begun between 4 P. M. and 4:30 P. M. with lamps set to run about six hours, and the house opened at daylight the next morning. By opening steam vents on the pipes a high humidity was obtained. No record was taken but at times the humidity was near saturation, at other times as low as 80%. Although the temperature was held close to 70°F, it ranged from 70°F to 86°F. Concentrations ranging from one to three times that recommended were used. In one house containing two varieties of strawberries, no injury was apparent even when as high as one pound per 3,500 cubic feet was used. No injury was evident on specimen plants of cotton, cucumber, chestnut, carnation, primrose, croton and lily placed in this house. Later, a second house containing many species and varieties of strawberries, raspberries and dewberries received two and three times the recommended dosage. Triple strength injured *Fragaria virginiana* var. *glauca* severely, and some horticultural varieties slightly although most varieties were uninjured. Citrus, crotons, grasses, poinsettias, ferns, arbor vitae and coffee were uninjured. One bramble species, *Rubus innominatus*, was slightly injured.

Both the lamp used to vaporize the naphthalene and the container should be well made. In the above tests alcohol lamps were used and in one instance the naphthalene was ignited. The ignited fumes severely injured the strawberry plants, though not the croton, bean, carnation, primrose or other plants.

It is felt that these notes should be of interest where the control of red spider is necessary in experimental plantings, especially where a number of different plants are grown in the same house.

GEO. M. DARROW, *U. S. Department of Agriculture*

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[1] Hartzell, A., 1926. Naphthalene Fumigation of Greenhouses, Jour. Econ. Ent. 10:780–785.

Developments in Trichogramma Production. At the Philadelphia meetings in December 1926, Professor E. O. Essig made a brief announcement of the methods developed by the writer for the artificial rearing of *Trichogramma minutum*. In the short period since that time information as to the equipment and technique used has been freely given to over a dozen entomologists in various parts of the world.

During the summer of 1927 a number of improvements were made by the writer over his original method which was essentially as described by Hinds and Spencer in the April issue of the JOURNAL OF ECONOMIC ENTOMOLOGY. It was found that by covering the corn bins with slats one-eighth inch apart and resting on the corn the bins could be built more compactly and thus conserve space. Instead of using the interspaces between two discs to obtain egg deposition it was found that when enough moths were placed in a smooth cylinder capped on each end with a 20-mesh wire screen their eggs dropped through the bottom screen. The crevices formed by the bodies of the moths stimulate egg-deposition.

The eggs are poured onto circular pieces of cardboard using shellac as an adhesive. The most convenient containers for handling the parasites are petri dishes inverted on plate glass shelves.

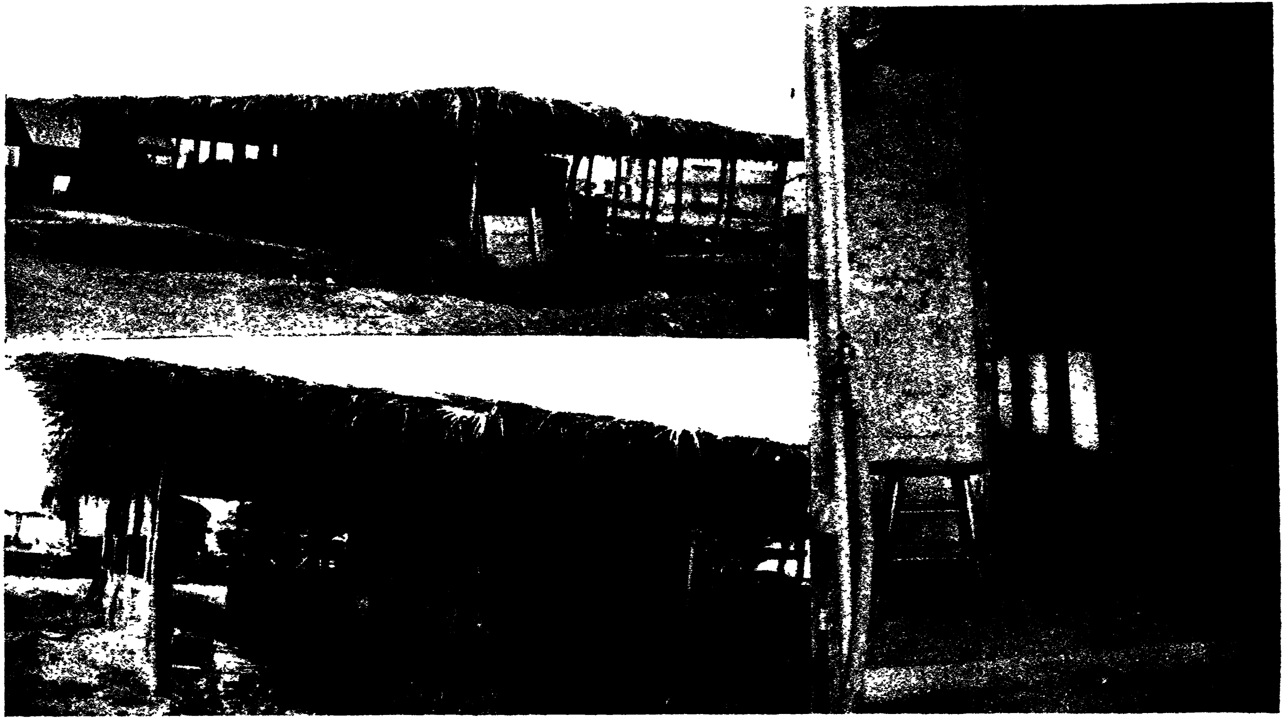
Throughout the month of July 1927 the writer maintained a daily production of over 200,000 *Trichogramma*.

STANLEY E. FLANDERS

Phi Sigma Scientific Program. The Phi Sigma Society will offer a scientific program at the New York meeting, on Dec. 27th, which will be open to junior research workers, whether members or not, in any field of biological science. While it is not contemplated to lower the standard of excellence in any way, it is recognized that there are often younger investigators who have produced meritorious results but who are not, for various reasons, eligible to section programs or to the programs of the more advanced societies. It is the purpose of this society then to offer a place where such investigators may present such work. This plan has the approval of the A. A. A. S. The Council of Phi Sigma will offer a prize of at least $50.00 for the most meritorious paper presented on this program by a non-member. Those wishing to present papers on this program should report their intention to the Secretary not later than Nov. 15, 1928 and should submit a brief abstract not exceeding 250 words. It should be understood that in bringing this matter to the attention of the scientific public in this manner, it is not the purpose to advertise the activities of Phi Sigma but merely to bring the plan to the attention of those to whom this opportunity may be of assistance. Authors need not be present but may delegate the reading of a paper to some one who will be in attendance. The Council reserves the right to place any paper on a list to be read by title. Papers will be limited to 10 minutes. So far as possible all papers of any merit will be admitted to the program. Programs of this nature were presented at the Kansas City and Philadelphia meetings with participation limited to members of Phi Sigma. The results have seemed to justify expansion of the plan as outlined above.

C. I. REED

Spray Recommendations for Codling Moth Control, Washington, for 1928. These were prepared by Representatives of the Washington State Experiment Station, The Federal Bureau of Entomology and the Washington State Department of Agriculture.



(*a*) General view of Coachella Valley (Calif.) Hippelates fly laboratory. (*b*) Rear view of T shaped adobe cool chamber showing breeding chambers with openings inside, (*c*) showing gallery of cool chamber with openings to breeding chambers and drip bag suspended from ceiling. At each end of space represented by the cross bar of the T is a work bench for microscope and other equipment.

1. The severity of codling moth infestation in the State of Washington depends on the temperatures at the time of emergence of the moth, length of growing season and degree of infestation the previous year. From year to year such infestation varies in intensity in different districts and in different orchards and in different portions of the same orchard. There is no reason to believe that the codling moth infestation is going to be less for 1928 than in former years.

2. Within a single district orchards vary in exposure, density of tree growth, type of cultivation, (whether cover crop or clean culture) and type of soil. All of these factors may affect the time of emergence and development of the codling moth.

3. Because of these variable factors specific spray recommendations cannot be given for an entire state or district. The spray program, while based on general principles, must be worked out in detail for each individual orchard.

4. Extensive experimental work for codling moth control was conducted in 1927 and will be continued in 1928. On the basis of this and former work, as well as practical results in commercial orchards the following is recommended as a guidance to the grower for 1928.

5. The general principles are here outlined for the guidance of the grower:

(a) Spray Treatment.

1. Arsenate of lead is the only known practical and effective insecticide that can be unconditionally recommended for codling moth control at this time. One pound of arsenate of lead to 50 gallons of water is usually sufficient. Heavier dosages are not recommended because of consequent difficulties of the residue removal.

2. Oil in combination with arsenate of lead has proven effective for codling moth control but is not recommended because of the possibility of injury to fruit and foliage. Oil alone is not as effective as either lead arsenate or the oil and arsenate combined.

3. Nicotine sulphate and other insecticides must be considered either ineffective or in the experimental stage. Do not use them except for experimental purposes.

4. The time of application, and number of sprays to be used will vary in different orchards and in different localities, and should be determined by each individual grower.

5. Major efforts for codling moth control should be directed toward first brood elimination.

6. The Calyx Spray should be applied before the calyx lobes have closed. Experimental evidence shows that this spray is important and should not be omitted.

7. The cover sprays should be timed carefully by the use of moth traps placed well up in trees, away from packing sheds or other buildings. The first cover spray should be completed within ten to twelve days after moths are caught in the traps. If thermometers are available, temperature records should be taken as soon as first moths are caught in traps. If the temperature is 60 degrees at dusk eggs will be laid and the first cover spray should be on the trees within ten to twelve days. Careful growers get the first worm for it is he that comes back to form the second brood.

8. On severely infested orchards cover sprays should be applied every ten days. In high altitudes or isolated orchards, having light infestation, one or possibly two cover sprays may suffice.

9. Cover sprays for first brood worms can stop ten days after moths practically cease to enter the traps. This usually comes five to six weeks after the first moths appear.

10. Second Brood Sprays: If there is an average of three to five worms per tree by July 1, or if moth traps show an increase in number of moths caught after July 1, one or more sprays for second brood should be applied.

(b) Thoroughness in all Sprays

1. Be thorough in spraying, cover every portion of the tree and give special atttention to the tree tops, since that is where the Extra Fancy apples grow and where most of the eggs are laid. Timeliness and thoroughness cannot be overemphasized.

(c) Supplementary Treatment

1. Destroy all overwintering larvae in warehouses, apple boxes, packing sheds and other buildings. Place all boxes within the packing shed of which all doors, windows and other openings are tightly closed during the spring and summer, in order to imprison the moths. Where a closed shed is not available all boxes should be fumigated. Avoid promiscuous transportation of infested apple boxes from one orchard to another.

2. Scrape rough bark from trees and burn to destroy overwintering larvae hibernating under the bark. This should be done to a depth of one to two inches below the ground.

3. Place moth traps well up in trees just before calyx spray is given, to catch many moths before eggs are laid.

4. Band trees June 1st and examine every ten days. Rough barked trees should be scraped before banding. The bands will catch approximately 45% of the worms that leave the apples.

5. Fruit should be thinned to break clusters and to remove wormy fruit. This should be destroyed and not buried.

These recommendations were signed by Station Director E. C. Johnson, R. L. Webster, Anthony Spuler, J. R. Magness, and M. D. Armstrong, Washington State College; E. J. Newcomer, U. S. Department of Agriculture, and J. I. Griner, George E. Harter, F. C. Neilson, and Wendell P. Brown, representing the Washington State Department of Agriculture.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1928

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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"WITHDRAWN FOR PUBLICATION ELSEWHERE"

Has the time not arrived to consider the unfairness of permitting a paper to be read at the annual meeting of the American Association of Economic Entomologists and then allowing it to be "Withdrawn for Publication Elsewhere?" Too often the paper is not published elsewhere at all; occasionally it is so changed as to be unrecognizable to those who may wish to read it as originally presented.

If a paper is worth reading, it is worth printing, and printing as read. If a paper is worth printing, it is worth submitting promptly to the Editor so that he is not forced to print the above caption after the title and the name of the author.

Reading papers by title is, happily, passing out of fashion. Papers at the annual meeting of the Association are not accepted for reading unless the author is present to read it. Would it not be just as fair to require that all papers read be submitted for publication immediately after reading?

V. I. SAFRO

There is considerable of value in the above. Papers read at a meeting should be represented in the published proceedings by an abstract at least. A public discussion should be available in its essentials to all members and so far as possible to all interested in the same special line. This gives opportunity not only for criticism but suggestion. The suggestion that papers be submitted promptly for publication to the Editor is a very practical one. Were this carried out, the Editor would know just about how much matter is on hand or how much there may be in the proceedings of a meeting or series of meetings, something very difficult to estimate under present conditions.

The Fourth International Congress of Entomology to be held at Ithaca, N. Y., August 12–18 promises to be the largest and most successful gathering of its kind, since there is practical assurance of the attendance of a hundred foreign Entomologists. It is safe to assume that there will be several hundred of the leading American Entomologists and the total attendance may run well toward a thousand. The gathering is destined to rank as one of the great scientific world congresses. The preliminary announcement indicates four general sessions with papers of broad interest to be presented by leading Entomologists of the world. The afternoons are to be devoted to meetings of sections and subsections dealing with various phases of taxonomic, morphological, ecological and genetical entomology. There are also sections upon medical and veterinary entomology, apiculture and general economic entomology, the last divided into five subsections. A week's time with such an inclusive program cannot fail to draw a large attendance from all sections of America. The committee in charge has also planned a comprehensive excursion, or series of excursions to include the more important entomological centers of the northeastern United States and for those who are interested in the scenic wonders of America there is an excursion to Niagara Falls. Provisions have been made for accommodations at reasonable rates, there even being opportunities for camping on the campus of Cornell University.

Obituary

GUSTAVE E. BENSEL

Gustave E. Bensel was born in Louvain, Belgium, on September 27, 1876. He received his education in the Belgium Agricultural College of Gembloux, from which school he received a diploma as Agricultural Engineer in 1899. For the first two years after leaving college, he was employed in the beet sugar industry of Belgium.

He came to America in 1902 and since that time has been connected with the sugar industry, principally in connection with agricultural research work where his broad fundamental training permitted achievement of valuable results in several branches of the field.

The Bureau of Entomology has lost a valued and respected collaborator in the passing of Mr. Bensel, whose death occurred on April 2, 1928, at Spreckels, Calif. His interest in the sugar-beet leafhopper problem was very great and his contributions of no small importance. These were never published, but the manuscripts were cheerfully handed on to his colleagues.

He was a member of the American Association of Economic Entomologists, the Entomological Society of America, and the American Association for the Advancement of Science.

His quiet personality and sincerity of purpose, coupled with a fine gentlemanly courtesy endeared him to his friends who mourn his passing, but who will remember him as one whom it was a privilege to know and a joy to work with.

WALTER CARTER, *Associate Entomologist,*
U. S. Bureau of Entomology, Twin Falls, Idaho

Current Notes

According to *Science*, Professor and Mrs. T. D. A. Cockerell left Siam in April for Australia.

Mr. O. T. Deen, of the Bureau of Entomology, was transferred from Picayune to Biloxi, Miss., on February 20.

Science reports that Professor J. Ritzema Bos has died at Wageningen, Holland, at the age of 78 years.

Mr. D. J. Caffrey, U. S. Bureau of Entomology, Toledo, Ohio, was a visitor at the Chatham, Ontario, laboratory on February 27.

Dr. E. P. Felt gave a lecture at the New York Botanical Garden on "Insects of Shade Trees and Ornamentals," April 28.

According to *Science*, Mr. W. M. Giffard, amateur entomologist, has been appointed research associate on the staff of the Bishop Museum, Honolulu, H. I.

Dr. P. J. Chapman, assistant in extension entomology at Cornell University, has been appointed entomologist at the Virginia Truck Experiment Station, effective May 15.

Mr. V. I. Safro gave a lecture before the New York Entomological Society, Tuesday evening, May 1, on "Some Interesting Phases of the Japanese Beetle Problem."

Mr. R. A. Blanchard, of the Tempe, Arizona, laboratory of the Bureau of Entomology, has accepted a transfer to take charge of the field laboratory at Sacramento, Calif.

Dr. R. D. Glasgow of the Department of Entomology of the University of Illinois, Urbana, Ill., has been appointed State Entomologist of New York vice Dr. E. P. Felt, retired.

Mr. Morgan Hebard, of the Philadelphia Academy of Sciences, visited the U. S. National Museum on March 29 and 30, and arranged some exchanges of Orthoptera with Mr. A. N. Caudell.

Dr. R. B. Fulton, recently Assistant Chief in Entomology at the Iowa Experiment Station, has moved to Raleigh, N. C., as Research Entomologist at the North Carolina Experiment Station.

Mr. George E. Gould of the University of Kansas was appointed Assistant Entomologist at the Virginia Truck Experiment Station, effective May 1, in the place of Harold S. Peters, who resigned.

On invitation, Dr. David E. Fink, of the Bureau of Entomology, presented a paper on "The Effect of Fluorides and Fluosilicates on the Respiratory Metabolism of Insects" before a symposium on insecticides of the American Chemical Society held in St. Louis, Mo., during April.

At the University of Kansas, a new biological building is being constructed, to be known as Snow Hall, at a cost of $200,000. The department of Entomology will occupy the first floor.

On February 21, Mr. F. T. Cowan, of the Billings, Montana, laboratory of the Bureau of Entomology, attended a meeting held at Fort Collins, Colorado, to discuss control of the Mormon cricket.

Mr. W. A. Thomas, Bureau of Entomology, of Chadbourn, N. C., returned to that place on February 23 after a visit to Green Cove Springs, Florida, to investigate a reported outbreak of the mole cricket.

According to Science, Dr. A. E. Cameron, Professor of Zoology and Entomology in the University of Saskatchewan, has been appointed lecturer in Medical Entomology in the department of Zoology in the University of Edinburgh.

The annual meeting of the British Columbia Entomological Society was held at Victoria on February 25. Messrs. E. R. Buckell, R. Glendenning, and W. Downes from the Entomological Branch attended the meeting and presented papers.

Messrs. B. R. Coad, Dr. J. W. Folsom, Dr. W. V. King, R. C. Gaines, K. P. Ewing, and Dr. F. A. Fenton, of the Tallulah laboratory, Bureau of Entomology, attended the meetings of the Southern Agricultural Workers at Memphis on February 1 and 2.

Dr. George P. Engelhardt, Curator of the Brooklyn Museum of Natural History, visited the Kansas State Agricultural College on April 30. He lectured to the class in Taxonomy concerning taxonomic work in general and his investigations of the Aegeriidae.

According to *Science*, Mr. T. H. C. Taylor, Entomologist of the Department of Agriculture of Fiji, recently visited the fruit-fly laboratory of the U. S. Bureau of Entomology at Ancon, Canal Zone, on his way from Trinidad to Fiji.

Mr. J. W. McGlamery of the Bureau of Entomology, and for more than six years connected with work on the sweet potato weevil in Florida, resigned on March 2 to accept a similar position with the Florida State Plant Board.

Mr. K. B. McKinney, Bureau of Entomology, returned to Clarksville, Tenn. on February 16 from a temporary assignment with the Federal Horticultural Board, and left Clarksville on February 20 for Tempe, Arizona, where he will inaugurate investigations on the tobacco stalk borer.

Mr. W. A. Ross, of the Vineland, Ontario, laboratory, attended a convention of the Ontario Fruit Growers' Association and the Niagara Peninsula Fruit Growers' Association at Hamilton early in March, and spoke on orchard insect conditions in the Niagara district.

Dr. William Schaus, U. S. National Museum, was in Boston March 11 to 15 examining various collections of Lepidoptera. He first visited Mr. Weeks, passed an evening with B. Preston Clark, and spent some time studying the collection in the Museum of Comparative Zoology.

Dr. J. M. Swaine, of the Entomological Branch, Ottawa, Canada, delivered a lecture on "Research in Forest Entomology" before the Forestry Club at the University of Toronto on February 24. While in Toronto, Dr. Swaine conferred with Mr. E. J. Zavitz, Deputy Minister of Lands and Forests, concerning cooperative forest insect work during 1928.

Mr. R. A. Cushman of the U. S. National Museum, who went to the Philippines last fall to attend to the packing and shipment of the C. F. Baker collection of insects which had been bequeathed to the Museum, returned to Washington on March 27. The collection is now on its way to the Museum.

On February 4, Mr. Oliver I. Snapp of the Bureau of Entomology gave an address on peach insects at the Mississippi A. & M. College, for the benefit of biological workers and students interested in entomology at that institution. He also attended the meetings of the Cotton States Entomologists in Memphis, Tennessee, February 1–2.

Dr. Adolph Dampf, of the Mexico Department of Agriculture, has been appointed collaborator of the Bureau of Entomology and will assist in the research work on the Mexican fruit worm. His headquarters will be in Mexico City. A temporary laboratory has been constructed at Cuernavaca, Mexico, where certain field work will be conducted.

Mr. E. W. Dunnam, Bureau of Entomology, who for a number of years has been stationed at Florence, S. C., conducting biological investigations on the boll weevil, has been transferred to Tallulah, La., where he plans to continue the same line of work. He will give special attention to the seasonal habits, dispersal, and chemotropic reactions of the weevil.

Dr. F. W. Poos, who has been Entomologist at the Virginia Truck Experiment Station at Norfolk, Virginia, for the past two years, resigned in April to accept a position as entomologist for the U. S. Bureau of Entomology in charge of a new project on the insects which transmit disease to cereal and forage crops, with headquarters at the Arlington Farm, Rosslyn, Virginia.

Dr. L. L. English, who has been working with the Crop Protection Institute doing special investigations with oil emulsions in connection with the control of scale insects, has become a member of the entomological research staff of the Alabama Agricultural Experiment Station, Auburn, Alabama. Dr. English will be located at Springhill, Alabama, doing special work in connection with citrus insects.

Early in February, Mr. F. W. Boyd, of the San Antonio, Texas, field laboratory of the Bureau of Entomology, made a trip through northern Texas to study the effects of the extremely cold weather on green-bugs. He reports that they continue to be abundant near Wichita Falls and in the neighborhood of Denton. So far as he was able to find, the cold weather has had no effect on them.

Mr. B. R. Coad of the Bureau of Entomology attended a meeting in Memphis, Tennessee, on March 30, of commissioners of agriculture, state quarantine officers and state entomologists of the Southern States, called to consider the problem of the pink bollworm in Texas. The sentiment of the meeting was unanimously in favor of the inauguration, at the earliest practicable time, of a plan for complete eradication of the pink bollworm from the North American continent.

According to *Science*, Dr. H. B. Hungerford of the University of Kansas, left on April 27 for eight months of research work in the museums of Europe. He took with him specimens from the collections of the University of Kansas and the Smithsonian Institution of Washington, D. C., with which he is collaborating on the trip. Dr. Hungerford planned to spend most of the month of May in British museums, going later to Paris, Brussels, Amsterdam, Berlin, Halle, Copenhagen, Prague, Vienna, and Budapest.

Science states that Professor E. O. Essig will conduct a University of California course in field entomology in the Yosemite National Park from May 14 to June 24, having headquarters at the new Yosemite Park Museum. During July he will be at his permanent summer camp at Echo Lake, in the High Sierras, 7500 feet altitude, eleven miles from Lake Tahoe, where he will be glad to assist visiting entomologists in relation to the various types of entomological work being carried on in the region.

Mr. B. L. Boyden, Associate Entomologist, Bureau of Entomology, formerly in charge of the sweet potato weevil work in Florida, and who has been employed by the Division of Truck Crop Insect Investigations in various assignments since 1914, was transferred to the Federal Horticultural Board, on February 1, 1928, to take charge of the work on eradication of the date scale at Indio, California. Mr. Boyden's selection for this difficult assignment was a recognition of the very effective work conducted under his direction in connection with the sweet potato weevil in Florida.

Dr. C. A. Weigel, Bureau of Entomology, returned late in March from a month's trip to the Pacific Coast, in the course of which he conferred with Dr. F. R. Cole of Santa Cruz, California, and C. F. Doucette of Puyallup, Washington, in regard to the work of the field laboratories at those places on bulb flies and other pests of narcissus and other flowering bulbs. While on the Pacific Coast, Dr. Weigel attended the fifth annual convention of the Northwest Florists' Association, held March 4–6 at Vancouver, B. C., and gave an address on "Insect Pests of Florists' Stock Grown under Glass." He also discussed the subject of "Bulb Insects and Their Control" before the Bulb Growers' section of the association at a meeting held in conjunction with the parent organization.

A meeting of officials in charge of gipsy moth control work in the infested states was held at the State Capitol, Hartford, Conn., May 21, to discuss gipsy moth conditions and plans of work for the coming year. Dr. W. E. Britton acted as chairman and called for a report from each state represented, and Mr. Burgess reported for the Bureau of Entomology. The following were present: W. G. Howard, H. L. McIntyre, Saul Phillips, Conservation Department, Albany, N. Y.; Dr. Thomas J. Headlee, State Entomologist, New Brunswick, N. J.; Dr. T. L. Guyton, Bureau of Plant Industry, Harrisburg, Pa.; Harold L. Bailey, State Department of Agriculture, Bradford, Vt.: W. A. Osgood, State Department of Agriculture, Durham, N. H.; E. L. Newdick, State Department of Agriculture, Augusta, Maine; George A. Smith, Grover C. Twiss, Conservation Department, Boston, Mass.; Harry Horovitz, Alvin J. Lannon, Department of Agriculture, Providence, R. I.; A. F. Burgess, S. S. Crossman, H. L. Blaisdell, John N. Summers,H. B. Dalton, Federal Bureau of Entomology, Melrose Highlands, Mass.; Dr. W. E. Britton, State Entomologist, New Haven, John T, Ashworth, Danielson, and J. A. McEvoy, Putnam, Conn.

Notes on Horticultural Inspection

On February 6, Mr. Orlando G. Fitzgerald was appointed as Junior Plant Quarantine Inspector at New York City.

Mr. Kirby W. Holloway was reinstated as Junior Plant Quarantine Inspector at the port of New York on March 8.

Mr. M. J. Forsell, Junior Plant Quarantine Inspector at Seattle, Wash., recently inspected bulbous iris imported under special permit in California.

Mr. Freemont A. Ballou, who was appointed on October 15, 1927, as Junior Plant Quarantine Inspector at Douglas, Arizona, resigned on April 30, 1928.

Mr. Lee A. Strong, Assistant Director of Agriculture of California, was in Washington early in April to confer with members of the Federal Horticultural Board.

Mr. James C. Moore, Junior Plant Quarantine Inspector, was recently transferred from the New York Office of the Federal Horticultural Board to Transportation and Storage Investigations of the Bureau of Plant Industry.

Mr. Morris F. Hartman died at his home in Cincinnati, Ohio, on April 17, after a short illness. Mr. Hartman had been employed at New York as Plant Quarantine, Inspector since November 10, 1924.

On February 8, Mr. R. W. Nicaise was transferred from New Orleans, Louisiana. to San Juan, Porto Rico, to fill the vacancy caused by the transfer of Mr Geraldus Gay to New Orleans, Louisiana, on March 3, 1928.

Mr. L. M. Scott and Mr. A. J. Bruman, of the Washington office of the Federal Horticultural Board, spent the month of April in inspecting narcissus and bulbous iris and other special permit material in the States of Virginia, North Carolina, South Carolina, Georgia and Tennessee.

Dr. S. B. Fracker, Senior Plant Quarantine Administrator in charge of domestic plant quarantine work for the Federal Horticultural Board, left Washington April 29, for Texas, New Mexico and Arizona, for the purpose of aiding in the administration of the pink bollworm quarantine.

Mr. Costillo Graham, a graduate of Mississippi A. & M. College, and Mr. W. T. Henerey, have been appointed to graduate assistantships in the Maryland State Horticultural Department and have entered upon such duties. Mr. Graham at present is engaged in Spray Service work and Mr. Henerey in soil treatment for the control of the Japanese beetle.

California issued Pest Control Regulation No. 3 (Revised), effective March 12, 1928, pertaining to the vegetable weevil. Under that regulation any of the host plants of the weevil shipped intrastate from the counties designated as infested must be inspected on arrival at destination by a California horticultural inspector.

Quarantine Circular No. 3 (New Series—Revised) pertaining to the cherry fruit fly (*Rhagoletis cingulata*) in certain counties in Washington was made effective on and after May 3, 1928. The fruit fly is known to be present in the Counties of Clarke, King, Pierce, Whatcom, and Whitman, in the State of Washington.

A California quarantine inspector recently intercepted a shipment of the following plants from Massachusetts: cut flowers, moss, evergreens, five-leafed pines, and willow scions. This shipment not only violated the gipsy moth and satin moth quarantines, but also the blister rust quarantine, and possibly the corn borer quarantine.

Reports received from the scouting staff engaged in examining areas in western Nova Scotia which have been infested by the brown-tail moth are encouraging. This insect has been established in Nova Scotia since 1906, but owing to spraying, natural control activities, and the destruction of winter nests, the infested area has been reduced each year. This season, up to the present time, no signs of the pest have been discovered.

Mr. E. C. Mandenberg, State Inspector of Orchards and Nurseries for the Michigan Department of Agriculture, writes: "Michigan is planning a drive early this year in connection with the raspberry mosaic. We hope to cover the entire raspberry acreage in the State from which plants will be taken before many of the aphids hatch out. There are no changes in our staff, but all the men who will be on the work will be men who have been in the service at least two years and longer."

An announcement made on March 14 by the Plant Board of Mississippi states that a regulation has been established effective on that date, governing the sale of certified (Irish) seed potatoes. The regulation prohibits sale of seed potatoes as "certified," "registered" or "inspected" stock unless by tags, certificates or other equally satisfactory evidence it is shown that the seed has been inspected and certified by the legally constituted certification authorities in other States, or by such other agencies as the Mississippi State Plant Board may approve.

The 10th annual conference of the Western Plant Quarantine Board will meet at Salem, Oregon, July 12, 13 and 14. This Board, as can be indicated by the number of its annual conferences, is the pioneer of the regional plant boards and promises to develop a very interesting program for its session. In addition to representatives from the eleven western States, British Columbia, Hawaii, and the Northern State of Lower California, there are always in attendance interested parties from all over the United States. This year two of the leaders in quarantine and pest suppression in the Republic of Mexico will meet with the Board.

Inspection to enforce the federal domestic plant quarantines in such terminal transfer points as Chicago, Kansas City, Omaha, and St. Paul, has been stopped for the spring shipping season at all points except in Chicago. Numerous violations, especially of the white pine blister rust, Japanese beetle, gipsy and brown-tail moths, satin moth, and black stem rust quarantines were intercepted. During the week of April 8, Dr. W. A. McCubbin, Pathologist, Department of Agriculture, Harrisburg, Pa., Mr. E. L. Chambers, State Entomologist of Wisconsin, Mr. F. D. Winter, Chief Deputy Nursery Inspector of Minnesota, and Mr. P. A. Eastman, Assistant Director, Bureau of Plant Industry of New York, were present in Chicago and inspected the methods of work. Doctor McCubbin, in commenting on the inspection, wrote: "I hope that that work, which is developing in such splendid manner, will be continued and enlarged until it forms a network of connecting type covering the channels of trade in such a way as to practically eliminate the danger of insect and plant disease spread through these trade channels."

According to Mr. L. A. Whitney, Associate Plant Inspector, Honolulu, Hawaii, a rice borer (*Chilo*, perhaps *oryzae*) was discovered during February affecting about 125 acres of growing rice. A preliminary survey determined that the borer is present in about 1,000 acres at the present time (April 5, 1928) and is apparently confined to Oahu. Larvae of the moth have been intercepted in rice straw packing from Japan on two occasions recently. All straw packing of imported merchandise is being removed and burned. An endeavor is being made to confine the infestation to Oahu by aid of a very stringent rule prohibiting the movement of rice straw or rice plants from that Island to others of the group. Mr. Fullaway left Honolulu March 22 for Japan where he is searching for natural enemies of the rice borer. Mr. Whitney also writes that the first recorded interception in Hawaii of the European earwig was made in a shipment of oak cordwood from Seattle. Since the interception all such shipments have been fumigated with carbon bisulphide as a condition of entry.

Apicultural Notes

The spring meeting of the Connecticut Beekeepers Association was held at Hartford, April 28. The principal speaker was Professor R. B. Willson of New York.

Dr. J. W. Bulger has been transferred from the Bee Culture Laboratory to the Washington office of the Bureau of Entomology with the rank of associate entomologist, where he will be engaged in compiling an insecticidal pharmacopœia in the Office of Deciduous Fruit Insect Investigations.

Recent visitors at the Bee Culture Laboratory of the Bureau of Entomology were: Lieut. Gen. Phya Vijitavongs, Minister to the United States from Siam, who visited the Laboratory in the interest of the development of bee culture in his native country, and Professor Herbert Osborn, Department of Entomology and Zoology, Ohio State University, Columbus, Ohio.

At the recent Indianapolis meeting of the Bee Industries' Association of America there was formed the "American Honey Institute." The object of this institute is to provide more educational publicity for honey so that its market may be increased. Dr. H. E. Barnard, who was formerly connected with the American Bakers' Association, is in charge of this new agency.

Mr. E. L. Sechrist, of the Bee Culture Laboratory of the Bureau of Entomology, left Washington early in April to spend several months in the Intermountain States, where a cooperative investigation is being carried on with the Bureau of Agricultural Economics in connection with a study dealing with the cost of honey production and systems of apiary management. About forty commercial apiaries in the States of Colorado, Wyoming, Utah, Montana, and Idaho will be used for obtaining data. Mr. R. S. Kifer, of the Bureau of Agricultural Economics, is expected to join Mr. Sechrist to assist with the work. Mr. C. L. Corkins, State Entomologist, Laramie, Wyoming; Mr. R. G. Richmond, Deputy, Apiary Inspection, Fort Collins, Colorado; Mr. D. H. Hillman, State Inspector of Apiaries, Salt Lake City, Utah; and Mr. O. A. Sippel, State Apiarist, Bozeman, Montana, are giving valuable assistance in this work.

Notes on Medical Entomology

Mr. C. B. Philip has recently accepted an appointment to investigate the yellow fever situation in central Africa on behalf of the Rockefeller Foundation.

Professor R. A. Cooley of the Montana State College and Station is now absent on a trip to Europe and Africa for the purpose of studying the parasites of ticks.

Mr. Robert C. Botsford, Connecticut Agricultural Experiment Station, has recently been called to Martha's Vineyard, Mass., and to Rye Beach, N. H., to advise regarding mosquito elimination from the rather large areas of salt marsh there.

According to *Science*, the degree of doctor of laws was recently conferred by Tulane University upon Dr. Aristides Agramonte of Havana, who was a member of the group of army officers—Reed, Carroll, Lazear, and Agramonte—which was appointed by the United States to conduct yellow fever investigations in Cuba soon after the Spanish War.

At the twenty-fourth annual meeting of the American Society of Tropical Medicine held in Washington May 1–2, several speakers touched on the subject of insects in relation to disease. The entomological profession was represented by Dr. L. O. Howard, Bureau of Entomology, and Dr. William A. Riley, University of Minnesota.

Dr. Hideyo Noguchi, member of the Rockefeller Institute for Medical Research, and Dr. William Alexander Young, Director of the Gold Coast Medical Research Institute of Yellow Fever, have died in Africa from African yellow fever contracted while investigating the disease. Dr. Noguchi died May 21, aged 51 years. Dr. Young was 39 years of age, and his death was announced in a dispatch from London, May 30.

Mr. D. C. Parman of the Division of Insects Affecting Man and Animals, Bureau of Entomology, spent the greater part of April in the Coachella and Imperial Valleys of California, studying the possibilities of trapping the gnats (*Hippelates* spp.), which are causing serious annoyance there. As a result of this work a trap was devised which shows considerable promise, as great numbers of the gnats were attracted and captured.

Mr. F. C. Bishopp, in charge of the Division of Insects Affecting Man and Animals, Bureau of Entomology, spent the greater part of April making a survey of the present status of the cattle grub in the north central states and conferring with entomologists and veterinarians at Kansas State Agricultural College, Kansas University, Iowa State College, University of Minnesota, and North Dakota Agricultural College regarding this and other problems relating to insects affecting live stock and poultry.

Dr. W. V. King of the Division of Insects Affecting Man and Animals, Bureau of Entomology, addressed the sixth annual meeting of the Florida Anti-mosquito Association at Jacksonville, March 29, on the subject of malarial mosquito control. Following this meeting, Dr. King, accompanied by Dr. Williams and Dr. Griffiths of the Public Health Service, visited a power project near Tallahassee, Florida, where water is being impounded over a large area. This visit was for the purpose of advising the local authorities concerning the mosquito breeding problems on the project and the possible utilization of airplanes in distributing insecticides for their control.

Erratum

Page 344, current volume, the legend of Fig. 22 should read "caught in 300 pails."

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PROGRESS REPORT ON THE USE OF PETROLEUM OIL AS AN INSECTICIDAL SPRAY

By E. R. deONG, *University of California*

ABSTRACT

A summary of established field practices in the use of petroleum oil sprays for both citrus and deciduous trees is given to date, together with data covering the species of insects concerned and the dosages used for same.

Dormant spraying of deciduous trees during the past year has been almost free from complaints of injury due to the better physical condition of the trees and the type of oil commonly used. Spraying of citrus trees is still accompanied with reports of functional disturbances which in part, at least, are considered due to oils of too low volatility. This may be overcome by use of two types of oil of different volatilities. In addition to the sulfonation test, the oxidation rate of oils gives promise of being another specification of value in determining the safety to the plant. The incorporation of nicotine or other active insecticides directly into the oil before emulsifying offers the possibility of increasing the toxicity of the oil itself without increasing the danger to the plant.

The year of 1926-27 has shown a marked increase in the use of petroleum oils, having a high unsulfonatable residue, both on citrus and deciduous trees in foliage. The common practice in the citrus districts of California is to use a 2% emulsion, largely of the quick breaking type[1], on both lemon and orange trees as a control for black scale, *Saissetia oleae* Bernard, red scale, *Chrysomphalus aurantii* Maskell, the purple scale, *Lepidosaphes becki* (Newman), citricola scale, *Coccus pseudomagnoliarum* (Kuwana) and citrus red spider, *Paratetranychus pilosus* C. & F., in combination with nicotine sulfate for aphis. Dates of spraying vary with the species concerned and the locality while the concentration of oil in the emulsion ranges from 1 to 2%. Commercial emulsions are decidedly predominant. Of the oil being used, only a very small amount is used as a home-made emulsion. Oil sprays have made very heavy inroads into the use of hydrocyanic acid gas for fumigation purposes although in the last year there has been the reverse tendency in some sections. This movement has been aided by the popularity of a combination fumigation and spraying program with but a few days interval between the two applications.

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[1] deOng, E. R., Hugh Knight, and Joseph C. Chamberlin (1927) "A Preliminary Study of Petroleum Oil as an Insecticide for Citrus Trees." Hilgardia (Calif. Exper. Sta.) 2:351-384.

Foliage spraying of deciduous trees attained widespread proportions during the summer of 1926, principally as a control for the red spiders (*Tetranychus spp.*) This practice is most common on prunes, and to a less extent on almonds and Kadota figs. Such sprays are not satisfactory on shipping plums as the bloom is dissolved, thus impairing their apppearance. The same type of emulsion and oil is used as on citrus trees but largely at a concentration of 1 to 1.5%. Much satisfaction has been expressed by prune growers over this type of spray, while the expense of a dollar to a dollar and a half for 100 gallons of spray is not greater than most growers will pay. Oil sprays on apples and pears, as a substitute for lead arsenate, is receiving an extended trial both in California and the Pacific Northwest but as yet no standard practice has been adopted.

Dormant spraying of deciduous trees, largely with commercial emulsions, is very general as a control for brown apricot scale, *Lecanium corni* Bouché, and closely related species together with San Jose scale, *Aspidiotus perniciosus* Comst., Italian Pear Scale, *Epidiaspis piricola* Del G., and the egg stage of the brown mite, *Bryobia praetiosa* Koch, citrus mite, *Paratetranychus pilosus* C. & F., and of defoliating caterpillars. The concentration of oil in the emulsion ranges from 2 gallons in 100 for the Lecanium scales and red spider eggs to 3 to 6 gallons for the armoured scales and as high as 8 to 100 for the leaf roller eggs (*Archips argyrospila* Walker) in the Pacific Northwest.

EFFECT OF OIL ON THE TREE.—The dormant spraying of deciduous trees during the winter of 1926-27 has been accompanied with fewer reports of injury, as noted by the author, than in any previous year where lubricating oil was generally used for spraying. This was apparently due first to the fact that abundant rains and the lack of dessicating winds placed the trees in a more resistant condition; second, the growing tendency among the manufacturers of oil emulsions to use a more highly refined stock,—the unsulfonatable residue ranging as high as 70%. The use of more highly refined oils for winter spraying is very desirable as a certain amount of the work is always done before complete dormancy in the fall or after the trees are beginning to grow in the spring at which times the tree is quite susceptible to injury.

Foliage spraying of deciduous trees, especially prune, almond and the fig and also on strawberries has occasioned almost no complaint. Some data has been accumulated indicating a reduction in the sugar content of prunes but this seems to be largely the result of very late spraying, when the fruit is beginning to ripen. This difficulty seems to be overcome by earlier spraying and the use of more volatile oils for late applications. There have been complaints of oil injury on apples in Oregon and Washington, but the author has not had a personal acquaintance with these.

The use of oil in citrus groves occasionally gives cause of complaint either to the tree or the fruit. This is not of an acute nature but rather a functional disturbance such as non-coloring of lemons, premature dropping of fruit, dearth of bloom and early decay of fruit in storage and transit. The validity of claims of damage of this nature are difficult to establish, but their persistence lends weight to the thought that there is ground for complaint. It is now generally conceded that a possible cause for this trouble is the use of oil which volatilizes too slowly and further study is being given to the selection of oils which will further minimize the possibility of injury. A cooperative attack on this problem is now in force between a number of Station and Federal entomologists, chemists and plant physiologists of the Pacific Coast and in this way it is believed that more rapid progress will be made than by each working on different types of oil.

TYPES OF OIL FOR SPRAYS.—The greatest progress in the development of petroleum oil for spraying has come thru the adoption of the sulfonation[2] test as a measure of safety to the plant. In addition to this criterion there should also be given the volatility factor as determined by evaporation, preferable below 100°C. while the distillation history is also of value as indicating the difference between "straight run" fractions and blends of oils of different constitution. The viscosity and the Baume is also usually given. Typical analyses made by the Chemistry Division of the California State Department of Agriculture of two foliage types of oils showing a wide range in their specifications is included:

	Unsulfonated Residue	Evaporation at 100° C.	Distillation Summary	Viscosity (Saybolt)	Baume
(a)	98–100%	34% in 42 hrs.	34% between 300°-350°C.	105–110	31
(b)	84–86%	83% in 42 hrs.	67% between 300°-350°C.	56–58	32

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[2] Gray, G. P. and deOng, E. R. California Petroleum Insecticides. (1926). "Industrial and Engineering Chemistry" 18:175-178.

Comparing (a) with (b) it will be seen that the Baume or specific gravity is almost identical, yet they differ markedly in evaporation, distillation and viscosity. A study of these last three factors shows that oil (b) is a much more volatile oil than is (a), although the specific gravity does not indicate this. These two types of oil will serve to illustrate the range in types of oils sold as commercial insecticides. Some manufacturers are offering similar oils to the two types described as a possible solution of the difficulties mentioned as occurring particularly in citrus groves. This seems a logical step in progress for oils penetrate to a variable degree into the inter-cellular spaces of the leaf and fruit and possibly into the cell itself. Here the oil may remain[3] for a period ranging from days in the case of kerosenes to months or possibly years with lubricating oils of low volatility in citrus leaves. The presence of oil in the air spaces between the cells interferes with the free exchange of oxygen, carbon dioxide and moisture, and possibly causes other complications, therefore, if the residence of the oil in the tissue is prolonged there may be considerable interference with the normal functions. Hence the quicker oils evaporate the less risk there is to the plant.

A much higher per cent of sulfonatable material is found in oil (b) than in the less volatile form (a). This is in accord with the theory that a slightly higher degree of sulfonatable material may be present in the more volatile oils without necessarily increasing the danger to the plant.

The oxidation rate is still another factor which is receiving increased attention as an important criterion of the value of an oil. This factor has been recognized for a number of years as an important specification of lubricating oils. T. S. Sligh, Jr., states[4] that "Mineral oils have a tendency to combine with oxygen, especially at high temperatures, forming undesirable oxidation products in the oil. Oxidation is accompanied by a discoloration of the oil, an increase in its viscosity, the development of acidity and finally the formation of precipitates of an asphaltic nature. The factors affecting oxidation are, (1) instability of the oil, measured by its tendency to form oxidation products; (2) presence of catalyzers tending to accelerate oxidation; (3) severity of exposure of the sample to oxidizing conditions. This exposure is dependent upon the temperature, duration of test, and degree of contact between the oil and oxygen during the test." Besides the above factors it should be noted that sunshine (a factor present in field work but not usually presented in laboratory tests, unless stimulated by violet ray) is considered to be important in calculating the rate of oxidation. We should not, of course, attach too much importance to the comparison of laboratory data (accumulated under artificial conditions) to those of field data, but experiments have already shown that oils exposed to standard laboratory methods of oxidation have given increased foliage injury in proportion to the amount of acidity developed. The latter factor is apparently of more importance than the development of sludge precipitate. Limited experiments have shown that certain oils containing a very high amount of unsulfonatable residue may oxidize more quickly than others containing large per cents of materials which will combine with sulfuric acid. Should further work confirm these findings, then it would be advisable to include oxidation "rate" or "number", whichever it may be specified, together with sulfonation as a further aid to evaluating an oil.

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[3] The presence of oil in the leaf itself is shown by darkened areas which appear more or less transparent by direct light or it may be located more exactly by microscopic examination of sections of leaves treated with stained oils.

[4] Sligh, T. S. Jr. "An Oxidation Method for measuring the Stability of Mineral Oils." (1924). Proceedings of Amer. Soc. Testing Materials. Vol. 24, Pt. II, Philadelphia, Penn.

COMBINING ACTIVE INSECTICIDES WITH OIL.—It has been shown[5] that the most highly refined petroleum oils have lost their most toxic insecticidal qualities and that complete kills of resistant scale insects is possible only by prolonged exposure, presumably through tracheal penetration, to oils volatilizing rather slowly. Such oils have been found to be subject to criticism from the standpoint of plant tolerance, while volatile oils such as kerosene, may be safer on the plant, but are not satisfactory scalecides. This leads to a study of the possibility of incorporating more toxic materials such as nicotine in the oil itself and emulsifying the latter as usual. Experiments on the brown apricot scale (*Lecanium corni*) with kerosenes containing small amounts of the alkaloidal nicotine, "free nicotine", have shown a decided increase in toxicity with but little if any difference in the degree of plant tolerance. A study of this matter offers the possibility of greatly increasing the toxic effect of oil, and at the same time retaining its penetrating qualities and wax solubility while the dangers resulting from too long a persistence of the oil in the plant tissue may be overcome by using more volatile fractions. Further work is now being done on this subject in the development of oil soluble nicotine salts which may be incorporated in the oil before emulsification.

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[5] Opp. Citation, deOng et al. Petroleum as an Insecticide.

THE USE OF OIL SPRAYS ON CITRUS DURING 1926

By R. S. WOGLUM, *Entomologist, California Fruit Growers Exchange, Los Angeles.*

ABSTRACT

Highly refined oil sprays were quite extensively used on citrus in California during 1926. Scale kill was quite satisfactory with some materials. Various injurious influences were sometimes noticed, such as retarded coloration, reduced crop and impaired quality. Avoidance of such injury has been attempted by particular attention to application, strength and fruit picks. Combination spray-fumigation is the most successful way of controlling resistant scales.

The use of oil sprays on citrus in California has been developing with great rapidity within the past few years. In order to encourage and stimulate this development along sound lines the Bureau of Pest Control of the California Fruit Growers Exchange has for 4 years been making a comparative field study of the commercial results of all insecticides used on citrus, particularly of sprays as compared with fumigation. Some of the outstanding developments of the past year are herewith presented in brief.

Several new oil emulsions of the highly refined lubricating type have been used on citrus. Most of these oils are generally high in unsulfonated residue but differ somewhat in viscosity and specific gravity. There appears to be a marked difference between the oils in the rapidity with which the oil film disappears from the tree. The speed with which the oil film disappears is reflected in scale kill as well as certain types of the injury. Some oils with the most lasting film requires several weeks before full effect on scale insects is determinable. Other oils less lasting but apparently more penetrating or with more toxic properties kill scale within a few days. The more smothering type of oil coating which remains long on the trees appears at certain times of the year, particularly the autumn, to exert an influence on bloosoming the following spring. This point was first brought out by the writer in 1926. This past year the reduction in blossoming has been equally apparent with that of a year ago in the case of certain sprays. Furthermore, it appears that certain oils which in one application have little effect on blossom reduction might have a considerable effect if twice applied the same season.

Although there was considerable retardation in the coloring of oranges in 1925-26 and influence on the coloring of lemons from certain oil sprays this injury has been little observed the past year. The trouble in 1925-26 arose largely from autumn and winter spray applications. The past year most oil spraying has been done in summer when fruit was of small size. Lemon picks were delayed for several weeks following the spraying.

This attempt to avoid cold weather spraying has reduced injury to a minimum. In addition to retarded coloration, heavy winter applications of oils which left a film of long duration sometimes also led to a softening of the fruit, puffiness and rough or pebbly appearance. It was also noted that in certain heavy sprayed orchards the fruit which was not picked until late summer the flavor was materially changed over that of fumigated fruit.

The scale kill on glossy surfaces such as leaves and fruit was superior to that on the wood with some of these highly refined lubricating oil sprays.

The combination treatment of an oil spray followed within a few days by fumigation, first used on citrus last year for resistant red scale, was continued with excellent results. Of upwards of 50 orchards examined following the double treatment only one fell below a 98 per cent kill. The oil spray is most effective on the fruit and leaves while the fumigation is best on the wood, therefore the combination works well. Oil appears to loosen the scale even when not destroying it and the fumigation is applied while in this condition. Furthermore, the oil appears to protect the trees so as to reduce the fumigation injury. Of upwards of 50 orchards double treated, only two showed any considerable fumigation injury although applied during a year of generally severe injury from fumigation. The time of application influences the period during which red scale is held in commercial control. Late August and September work is decidedly more lasting than July treatments.

The citrus red spider is a common pest of citrus. The control of this pest by the use of oil sprays varied both with the type of oil used and the time of application. Certain sprays gave temporary control but the spider returned within a few months. Other sprays appeared to give control for almost a year. The month of application influenced the permanency of results greatly. In certain orchards sprayed in July with good results the spider returned the following spring. Others in which the time of application was September carried through for the entire year.

SIGNIFICANCE OF MID-SEASON UNITS COUNTS ON RESISTANT BLACK SCALE

By A. F. SWAIN, *Citrus Entomologist* and CHARLES E. DUGGAN, *Field Entomologist, California Cyanide Company, Los Angeles, Calif.*

ABSTRACT

In the resistant black scale area in the citrus belt of Southern California, where the "unit system" is used to determine the degree of scale infestation, it has been applied only to mature scale in the spring. No method, other than one of estimation, has been used to determine this at any other season of the year. The writers have carried on observations throughout the past season to secure data on the significance of units counts on immature scale. Their methods and observations are recorded herewith.

INTRODUCTION

Of the various scale insects attacking citrus in Southern California, the black scale (*Saissetia oleae* Bern.) is the most important from an economic standpoint. In the 1926-27 season approximately 60,000 acres of citrus in California were fumigated and about the same amount sprayed. Of this, 40,000 acres were fumigated and 30,000 sprayed primarily for the control of black scale. In other words approximately $1,500,000.00 was spent by the citrus growers of Southern California in an attempt to control black scale. Until about 15 years ago, fumigation was extremely effective as a control for black scale in all sections, but at that time it was observed that in a few orchards in the Covina Valley of Los Angeles County, satisfactory control was not obtained. Since then, this area, where unsatisfactory results obtained, has extended gradually year by year until now it covers almost the entire inland citrus belt of Los Angeles County and the eastern portion of the San Bernardino County, a territory some thirty to thirty-five miles in length with about 40,000 acres of citrus. The outlines are each year spreading until now it is impossible to foretell what the future status of this insect may become.

Apparently a strain of black scale has been developed that is more or less immune from or resistant to hydrocyanic acid gas. To date no theory as to the cause of this phenomenon has been generally accepted, although the tendency is toward an hereditary immunity being built up. The scale in this area is generally spoken of as "resistant" black scale and the particular district in question as the "resistant" area.

In this resistant area it is not uncommon to observe groves with a 75% to 90% crop reduction due to the effect of the scale during a single season. Many growers endeavoring to control the scale have spent much time and money and have suffered severe crop losses through unsuccessful control measures.

With the 1926 fumigation season, the California Cyanide Company introduced anew feature in insect pest control, namely: "Guaranteed Pest Control." A commercial kill of the particular insect pest for which the fumigation was applied was guaranteed, the same being described "as one satisfactory to the Horticultural Commissioner, or his authorized deputy, of the County wherein the property fumigated is located." In this area where more than one treatment is frequently necessary, an important factor is to determine soon after treatment whether a second is needed in order to secure control of the scale. There is no standard method to determine this condition. In fact the method generally practiced to determine the degree of infestation is one of estimation. It is true a keen observer, thoroughly experienced in a certain locality, can oftentimes decide if a grove will require further treatment. Many, however, are not qualified to give dependable decisions. The fault, considering all concerned, is the tendency to avoid a close decision and, if the issue is doubtful, to indicate further treatment. No system wherein actual figures are used has been established for mid-season observations. In Los Angeles County a system based on estimation is used. This work is carried on primarily as a basis for the recommendation of treatments for the following season and secondarily for the comparison of results obatined by the use of various insecticides. The Bureau of Pest Control of the California Fruit Growers' Exchange use a method of "unit counts" as a means of comparing the efficiency of various insecticides. In this method[1] scale-bearing twigs six to ten inches long are picked from the north side of the tree and the number of living scale counted. Enough twigs are examined to typify the scale condition of the tree and the average number of scale found is computed. This then gives a figure that is comparable with figures from other groves where twigs are similarly chosen. This past season the Los Angeles County Horticultural Commissioner used a similar system of unit counts in conjunction with the estimation system, primarily as a check to establish more uniformity in the inspector's results.

This system has been applied only in the spring after the scale have migrated from the leaves onto the twigs and have become mature. For purposes of determining whether further treatment is needed for control of the scale, it is necessary to have some basis of estimating the degree of infestation during the fall and early winter. The unit system has been used heretofore entirely for spring inspections. The writers this past fall began observations on several orchards scattered throughout the resistant area in an attempt to obtain figures as to scale infestations on a unit system which could be applied to immature scale.

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[1] Woglum, R. S. "The Values of Sprays and Fumigation for Resistant Black Scale Control." Bulletin, California Fruit Growers Exchange, July 1925.

Any system must be applicable to all varieties of citrus and it must be consistent in its application to groves treated with different materials or methods. It must of necessity be simple or at least capable of being applied by different persons. It is felt by some that it requires too much time to ascertain the condition of a grove by unit counts. It is felt by others, however, that if a portion of a crop or the cost of a treatment rests with the decision, a reasonable amount of time is justifiable. Still others take the stand that a method must of necessity be simple only in that uniformity may be established among investigators and officials upon the application of a reasonable amount of time.

In this work units were selected from trees on the two diagonals across the orchards and rows across both ends. As the work progressed it was found to be unnecessary to select units from trees across the ends as the two diagonals gave comparative results. It was further observed that, in the early season, units selected from every other tree on the diagonals gave averages comparable to those from units selected from every tree. However, as the season progressed there was greater variation in type of units, so units were then selected from every tree.

It is in the selection of the units that the greatest opportunity for variability appears. A thorough knowledge of the botany and growing habits of citrus trees is absolutely necessary. Placement of scale upon the tree not only varies with different districts but also with individual groves. This variation is influenced by fertilization, pruning and cultural methods and increases as the season advances and more new growth appears. In June and early July after the scale hatch, and until the next period of new growth appears, sometime in mid-summer, the scale are to be found on foliage and wood throughout the tree. Units are easily selected with excellent uniformity at this time. Later a third period of growth appears, more or less sheltering the mid-summer growth which becomes infested with young scale. This third period of growth is irregular in appearance and is followed by other growths as the season advances. Because of the variation of these growths in the different orchards, it is very easy to select units which are not typical of the infestation. The investigator can select satisfactory units only by carefully judging the placement of the scale before commencing his selection.

On counts made during October, November and December, when the majority of the scale are on the foliage, great care must be exercised in the size of the units and in the number and size of the leaves on the units chosen. In this work binoculars were used to examine both the foliage and the wood until in the spring when the scale were well grown. All questionable scale were punctured with a needle. Each leaf was severed from the unit after examination and before commencing another thus making it easier to see the scale. To expedite the work of the counts, a record was kept of 16 groves to determine if it was necessary to examine the under sides of the leaves for scale. The results of these examinations (Table 1) point out that it is not necessary to examine the under portion of the leaf. In none of the groves does the number of scale on the bottom of the leaf affect the final figure of the count sufficiently to justify the time of making the examination.

TABLE 1. PROPORTION OF SCALE ON BOTTOM OF LEAF

No. of scale per unit	No. of scale per unit on bottom of leaf	Percent of scale on bottom of leaf
.55	0.	0.
.94	.055	5.8
3.2	.16	5.
1.0	.04	4.
2.4	.266	1.08
2.92	.095	3.2
17.78	1.04	5.85
.79	.04	5.06
1.00	.033	3.3
1.22	.04	3.27
2.27	.22	9.69
2.46	.06	2.43
2.78	0.0	0.
1.00	0.0	0.
2.26	.034	1.5
6.05	.066	1.09

MORTALITY

As the season advanced successive counts on several groves indicated that the method of counting was dependable. However, the application of the figures obtained to commercial control was questionable. No records existed on the mortality of the scale in this district. The counts indicated that a large natural mortality was taking place. This mortality was either a normal condition or was influenced by one or more of the following elements; precipitation, wind, temperature and parasitism.

A comparison of the monthly percentages of mortality (Figure 33) with the precipitation (Figure 34) does not indicate any unusual influence on the mortality of the scale. The low month, January, with .95 inches of

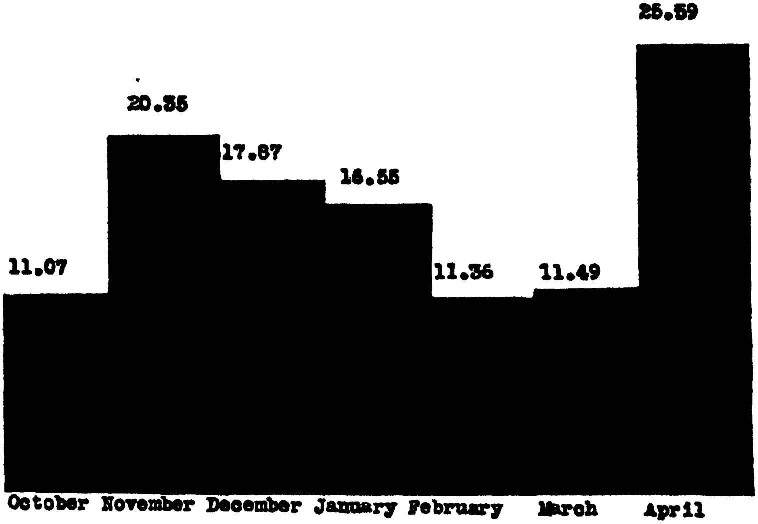

FIG. 33.—Average monthly percentage of mortality, October 1926–May 1927.

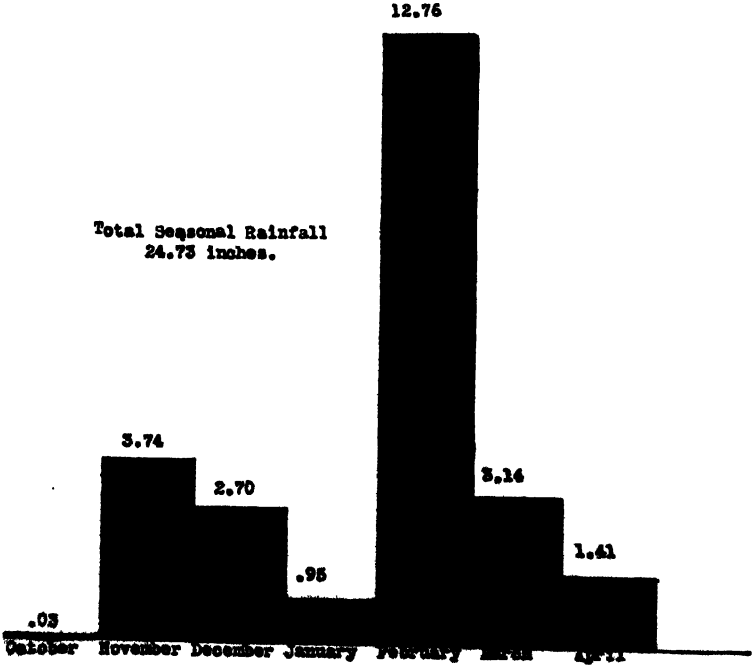

FIG. 34.—Monthly rainfall, Pomona, California, October 1926–May 1927.

rain and the high month, February, with 12.76 inches apparently show no particular influence on the mortality. A close check of the individual inspections of the groves shows no connection with excessive rain fall.

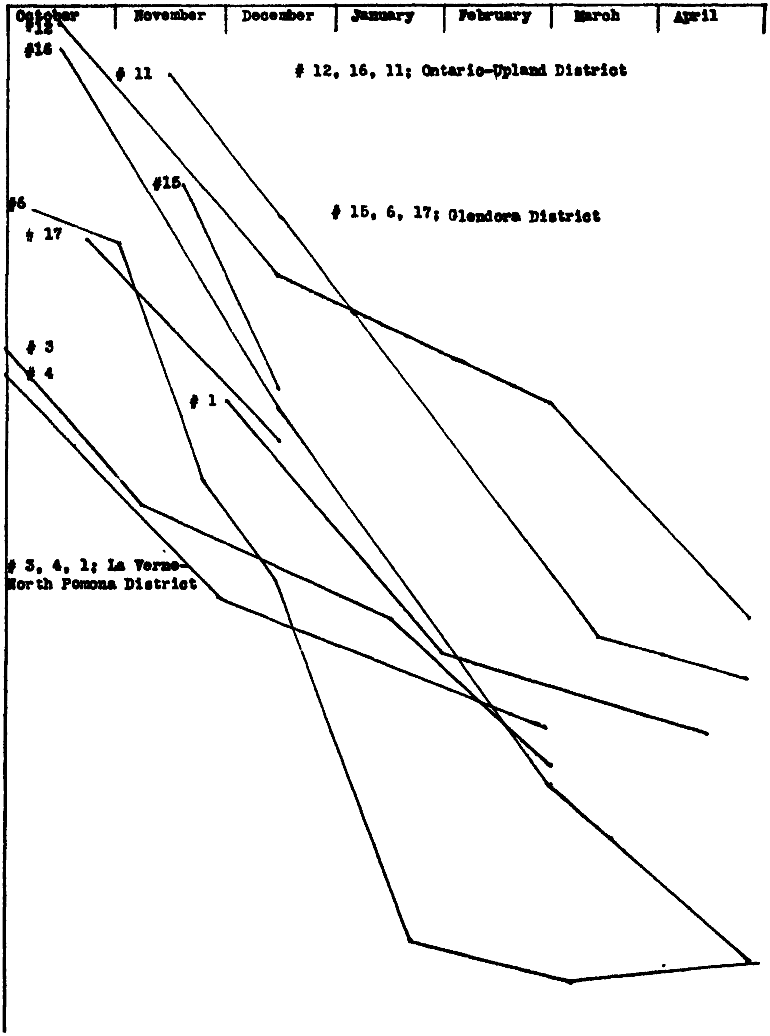

FIG. 35.—Individual orchard mortality curves.

A severe north wind the early part of December caused a heavy defoliation of trees in groves located in the Glendora and Ontario Uplands districts. This defoliation removed large numbers of leaves bearing living scale, particularly on the north sides of the trees where the majority of the scale are found. This condition influenced the counts somewhat, although an effort was made in later counts to select units bearing the old foliage. In Figure 35, the mortality in groves located in the Glendora and the Ontario-Uplands districts is compared with that in groves located in the LaVerne-North Pomona district which is between the Glendora and the Ontario-Upland district. The LaVerne-North Pomona groves did not receive the defoliation of the other districts Groves 12, 16 and 11 in the Ontario-Upland district showed an average mortality of 84%, while groves 3, 4 and 1 in the LaVerne-North Pomona district showed a mortality of 61%. For this comparison the groves in the Glendora district, groves 15, 6 and 17, could not be used as records were not kept for the entire season. The tendency of curves, however, is to bear out the conditions in the Ontario-Upland district.

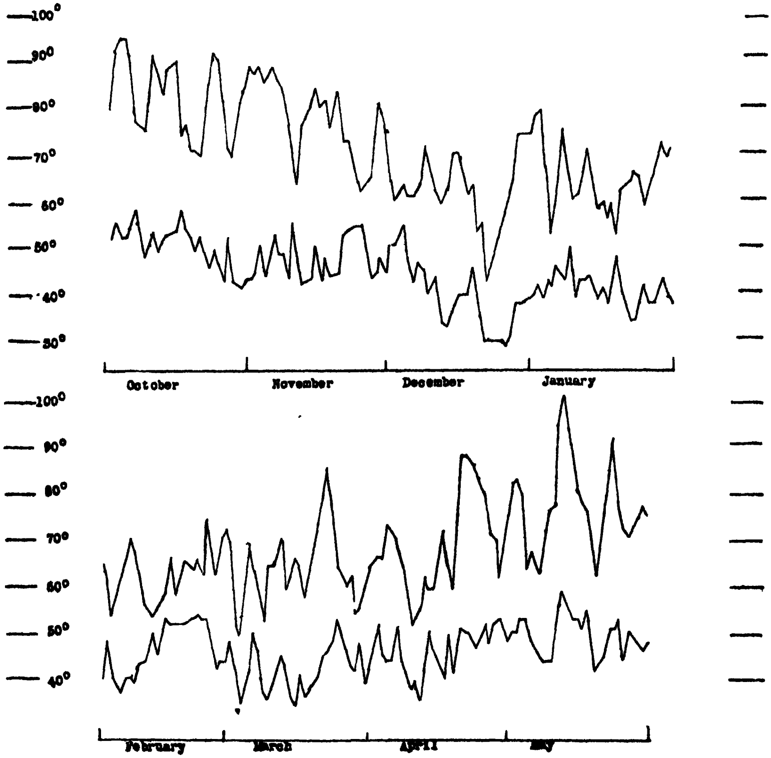

Fig. 36.—Daily maximum and minimum temperatures, Pomona, California, October 1926–May 1927.

Excessively high temperatures are responsible for a high percentage of mortality. This is especially true in the early summer when the scale are just hatching or are still in the first or second instar. A week in June, 1917, with maximum temperatures each day from 99° F. to 117° F. brought about an extremely effective control of the black scale in the interior districts of Southern California. Ordinarily during June and July there is a mortality in the young scale ranging upwards from 50% due largely to high temperatures. However, the scale increases in size as the season advances and is, therefore, less apt to be affected by high temperatures. After August it is doubtful if temperatures under 100° F. have any effect on scale mortality. October 1926 and May 1927 are the only months (Figure 36) having temperatures over 90° F. The temperatures in May are, of course, irrelevant as the scale are mostly in the rubber stage or mature and ovipositing. The average mortality of 7 groves covering a period from October until December was 37.02%. This compared with a mortality of 46.88% during the period of January to May. This apparently indicates that the temperatures of October were not sufficiently high to affect the scale.

One parasite (*Aphycus luteolus* Timb.) could be said to influence the counts. The work of this parasite was very general and in some groves of considerable importance in killing immature scale. The counts in late spring revealed larvae of *Aphycus lounsburyi* Howard and *Scutellista cyanea* Mots. These parasites very seldom affect the commercial condition of lightly infested groves except when in close proximity to those heavily infested. Many predators were observed but none in sufficient quantities to influence the counts.

MIGRATION

The average monthly percentage of total migration is shown in Figure 37. The migration is quite gradual from October until February, less than 15% of the scale migrating each month. In March and April approximately 50% of the scale migrates. Comparing this with Figure 33 it will be observed that the mortality approximates very closely the migration. Following the greatest period of migration appears the greatest loss in scale numbers or in other words the greatest mortality is found following the period of greatest migration.

OFF-HATCH

The area under consideration in this investigation is definitely an even hatch area. There seems to be a tendency, however, in many

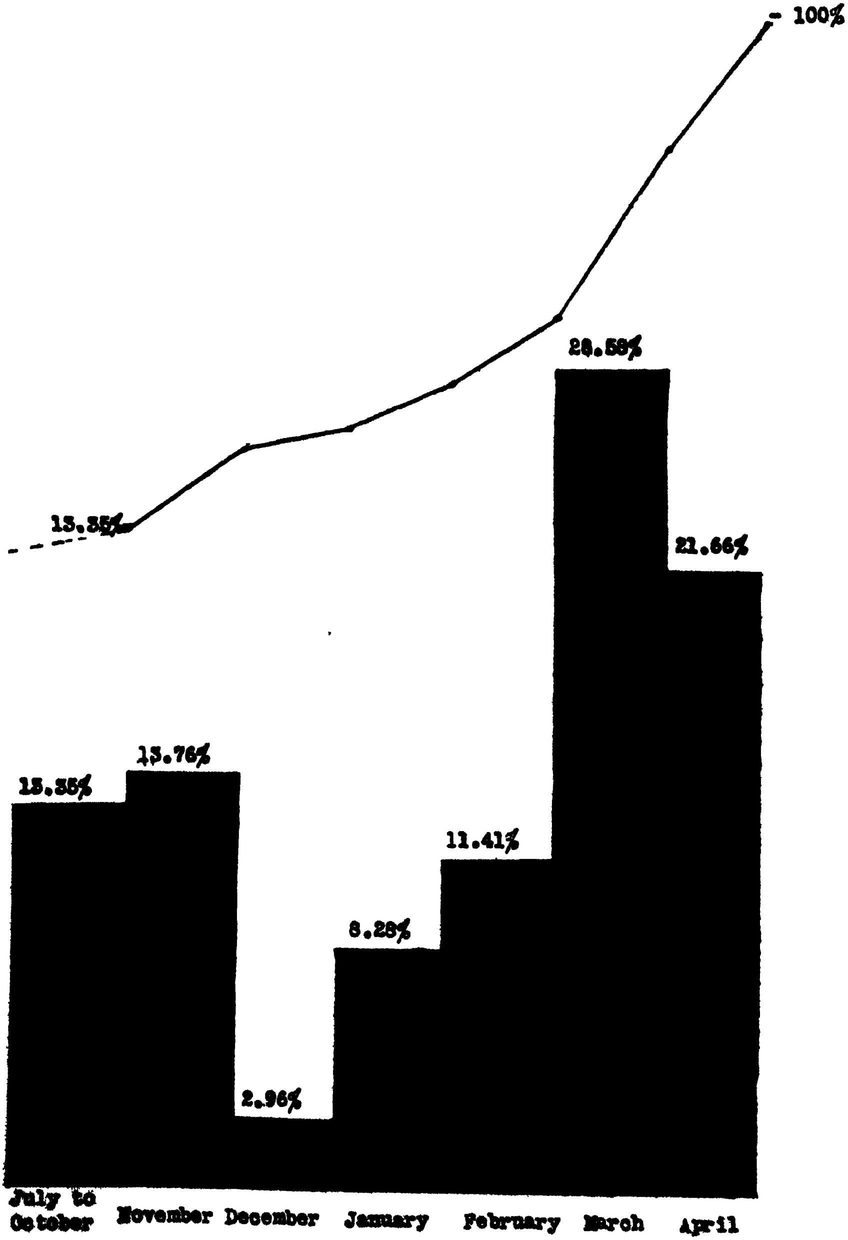

FIG. 37.—Average monthly percentage of scale migration.

groves for the scale to attain an uneven size. This condition is intensified in groves which have been improperly sprayed and in groves where the infestation is very heavy. Groves inefficiently sprayed and groves fumigated with liquid HCN at low temperatures show a larger proportion of the remaining scale in the tops of the trees. These scale, located in the warmer portions of the trees, are prone to mature more quickly, thus creating an off-hatch condition. During every month of the period covered in this investigation scale were found to be hatching. In seven groves which showed off-hatch during the season there was an average mortality of 49.98% as compared with an average mortality of 75.87% in eight groves not showing off-hatch. This indicates the importance of an off-hatch condition.

Ryan and Woglum in their methods of counts, using similarly sized units, state that any grove having an average of 1.5 mature scale per unit is commercially clean. The average per cent of mortality this past season including groves with an off-hatch condition was 63.73%. Since all applications of counts were made after October 1st, it would appear that if in a particular orchard there were 4.13 scale per unit present on October 1st, through natural mortality the chances are that by spring, and maturity of the scale, there would be but 1.5 per unit left. Of the seven orchards under observation (Table 2) where there were more than 1.5 live scale per unit in October or November and where no off-hatch appeared to off-set the natural mortality, six showed 1.5 scale per unit or less at the spring inspection. While there were not many groves with early inspections, these figures indicate that a grove showing less than 5 scale per unit in October will by natural causes be commercially clean at the maturity of the scale.

TABLE 2. CORRELATED FALL AND SPRING UNIT COUNTS

Grove No.	Month Inspected	No. scale per unit	No. scale per unit in Spring	Commercially clean
4	October	2.70	1.13	yes
5	October	5.43	2.44	no
8	November	4.97	1.5	yes
9	November	2.4	.62	yes
11	October	3.04	.48	yes
12	October	4.08	1.0	yes
14	October	3.08	.3	yes

SUMMARY

The absence of an accurate method for determining the degree of infestation has caused many losses, because of improper advice. All unit counts made prior to the 1926-27 season were for the purpose of comparing materials or methods of control and were made in the spring on mature scale. Observations in this investigation were commenced in the fall and continued until the scale were mature or until the grove was retreated.

A twig six to ten inches in length bearing eight to twelve leaves was chosen from alternate trees in alternate rows and from the ends. Later units selected from each tree on the diagonal gave similar results. Until the scale were at least half grown, binoculars were used on all counts.

Considering all the elements, precipitation, wind, temperature and parasites, none seemed to have any unusual effect upon the mortality except the wind in certain districts. Off-hatch scale affect the counts made before October and possibly in some groves after this period. This can usually be determined by the investigator in an inspection of the tops of the trees, and thus avoid a discrepancy. The junior writer made all counts personally, therefore, it may be necessary to increase the number of units chosen from the individual tree in order to decrease the probability of error, if this method of unit counts is to be generally used.

The figures indicate that orchards where counts made prior to October show less than 5.0 scale per unit were commercially clean by the maturity of the scale in June. Similar observations must, of course, be carried on for several successive seasons before any definite degree of normal mortality can be stated.

BEET LEAFHOPPER, *EUTETTIX TENELLUS* (BAKER) DOES NOT OCCUR IN THE ARGENTINE REPUBLIC

By Henry H. P. Severin, Ph.D., *California Agricultural Experiment Station*
and Charles F. Henderson, B. S., *California Agricultural Experiment Station* and *U. S. D. A. Bureau of Entomology*

According to Boncquet (1) the beet leafhopper, *Eutettix tenellus* (Baker) has been found in the vicinity of "Buenos Aires, in Guatrache, Alpachiri and Bahia Blanca (South-East), in Colonia Alvear and Mendoza (West) covering the major part of the temperate and sub-tropical zones of the Argentine Republic." Leafhoppers which were reported to have been collected at San Isidro, a suburb of Buenos Aires, were determined as *Eutettix tenellus* (Baker) by E. P. Van Duzee and Severin, and are in the collections of the California Academy of Sciences.

Henderson who was sent to Argentina to introduce parasites of the beet leafhopper into the United States failed to find *E. tenellus* in any of the localities in which Boncquet stated that it occurred. During the exploration from November 11, 1926, to June 30, 1927, the most favorable host plants of the beet leafhopper were swept with an insect-net in the same and many other localities. Insect collections in museums and of entomologists were examined, but not a single specimen of *E. tenellus* was found.

The following question has been asked by a number of scientists: If the beet leafhopper does not occur in Argentina, how do you explain the fact that Boncquet submitted *E. tenellus* for determination from that country? In a letter dated June 14, with permission to quote, Boncquet states that *E. tenellus*, preserved in a bottle of alcohol, was taken from the United States to Argentina, and that collections of leafhoppers preserved in formaldehyde were made in various localities in the Argentine Republic and the Panama Canal Zone. He writes, "The various sample bottles were identified by marks made on the stoppers; the possible mixing of the stoppers is only manner in which I can explain the confusion."

Boncquet admits that he is not acquainted with the specific characters of *E. tenellus* and his determination of the species hinges on "general appearance." An undetermined species of *Eutettix* resembling the general shape and size of *E. tenellus* was collected by Henderson on sugar beets, garden or red beets, and Swiss chard, in every locality in which Boncquet reported that *E. tenellus* occurred except in Guatrache.

In 1925, Fawcett (2) published a paper stating that *Aceratogallia sanguinolenta* transmits a disease in Argentina similar to curly-top of sugar beets except that the blackened concentric rings which alternate with light areas in a cross section of a beet root affected with curly-top are absent. The darkened phloem areas of the fibro-vascular bundles, however, are not a reliable and constant symptom of curly-top.

Fawcett received his determination from W. L. McAtee who in a letter to Severin dated April 19, 1926, stated that the Argentine leafhopper was a species of *Aceratogallia* and resembled the dark specimens of *sanguinolenta*. "My expression 'dark variety' became 'obscure variety' in translating."

During the past ten years a large number of tests have been made with many different species of leafhoppers, among them *A. sanguinolenta*, but *E. tenellus* is the only species which has been found so far to transmit curly-top. A letter dated April 6, was written to Fawcett calling his attention to the fact that *A. sanguinolenta* failed to transmit curly-top to sugar beets in California.

Fawcett sent to Severin specimens of *Aceratogallia* which his experiments have shown transmitted the disease to sugar beets. These leafhoppers were sent to H. Osborn, E. D. Ball, and E. P. Van Duzee for determination. Osborn had already received some specimens direct from Fawcett. The species was identified as *A. sticticollis*. Ball writes, "Of Stal species, *sticticollis* comes nearest to fitting the species." Fawcett (3) in a later paper adopted the specific determination of Osborn.

Experiments were conducted to determine whether non-infective *E. tenellus* could transmit curly-top to healthy sugar beets after feeding on beets infected by *A. sticticollis*. Fawcett kindly sent two shipments of diseased beets which had been infected by *A. sticticollis*. The beet roots from the first shipment failed to develop leaves and those of the second shipment were decayed. Two hundred and fifty non-infective *E. tenellus* were fed on three beet roots which had been infected by *A. sticticollis*. The *E. tenellus* were then transferred to healthy beet seedlings, but not a single case of curly-top developed. No importance can be attached to this experiment, however, since the virus may have been destroyed by the souring of the juice.

Henderson, upon his return from Argentina, left at Washington specimens of diseased Swiss chard taken from a vegetable garden at San Isidro. This material has been placed in the hands of E. W. Brandes who turned it over to E. Carsner for experimentation.

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IMPORTANT COTTON INSECTS OF CENTRAL PERU

By W. E. Hinds, *Entomologist, Louisiana Experiment Station*

Abstract

During a six weeks investigation of cotton insect problems in the Canete Valley, located about 100 miles south of the city of Lima, in central Peru, no evidence was found of the existence in Peru of either the Mexican cotton boll weevil or the pink boll worm. The Peruvian square weevil was found in nearly all fields examined and ranged from sea level to an altitude of over 2,000 feet. This species attacks only small cotton squares and causes them to flare and fall to the ground as do the squares attacked by the boll weevil. The square weevil is a small species, adults measuring from 2.5 to 4 mm. in length. The color is light tan or brownish but the integument under the scale covering is brown. The adults are extremely active and shy and are hard to find in the field but the flaring and falling of squares betray their presence. Usually only six or eight punctured squares occur on a plant but sometimes as many as twenty-five were found, these being apparently the work of one female. The development requires some sixteen or eighteen days and the larvae and pupae in fallen squares appear to be quite resistant to heat and drought. It is not known whether the species can survive freezing temperature during its hibernation period.

The most serious cotton pest in Peru seems to be a species of leaf worm. (Possibly more than one species is involved.) This species appears to be native and occurs abundantly every year, requiring usually three poison applications during the season. At least four generations of this leaf worm must occur. The observations made indicated a developmental period of from twenty-two to thirty days. The multiplication is rapid in spite of the presence of a number of species of predators and parasites. The usual method of control has been arsenate of lead or calcium arsenate sprays applied by knapsack spray pumps carried by Indian workmen. These spraying squads often numbering over 100 men, do nothing else for three months but spray for leaf worm control. Their work is very inefficient. Dusting has been started to replace the spraying and has given much better control of the worms with a very great saving in the time and labor of application. The climatic conditions and the topography of the irrigated valleys are ideal for airplane dusting work and such work is being started this season in Peru.

Other important insects include several species of small caterpillars which bore into the developing bolls. Their work is followed by the spread of fungus diseases which complete the destruction of the bolls. By this combined attack a damage of from 20% to 25% of the crop is frequently experienced.

General Agricultural Considerations

At the request of a group of Peruvian cotton growers, the writer made a brief study of the most important cotton insect pests and cotton production problems in a section about one hundred (100) miles south of the City of Lima, the capital of Peru. The particular section studied is known as the Canete Valley, but some observations made in other valleys both north and south of the Canete Valley indicated that the principal cotton pests were common to at least the central section of

Peru. In contrast to the situation of the Cotton Belt in the United States, which is a broad band about three hundred (300) miles wide and extending eastward and westward between approximately thirty and thirty-five degrees (30° and 35°) north latitude, the culture of cotton on the western coast of South America is confined practically to a very narrow strip close to the ocean but extending from about five to twenty degrees (5° to 20°) south latitude. This represents a coast line distance of nearly fifteen hundred (1500) miles extending from a northwesterly to southeasterly direction.

Throughout this distance the production of cotton and most other cultivated crops including particularly sugarcane, rice, etc., is confined very closely to the irrigable valleys. Rains occur only in the northern part of Peru and in the mountain ranges at elevations above three thousand (3,000) feet. Many small valleys with only a short drainage slope above them receive water only once in two or three years, but it is amazing how the people make use of this scanty and irregular supply and produce a succession of crops. In the larger valleys where streams rise high up in the mountains, the water supply may be more than sufficient to meet all requirements for irrigation. The principal streams running down the very steep slope of the Andes fall from a height of from sixteen to twenty thousand (16,000 to 20,000) feet to sea level within a distance of from one hundred (100) to one hundred and fifty (150) miles. The force of water coming down these narrow valleys is almost irresistible, but near their mouths the valleys widen out as the streams have washed back and forth across them, forming rather level valleys in which irrigation can be practiced with field crops.

In these irrigated valleys most of the land is held by a comparatively few companies, estates, or large individual owners. There are comparatively few "small farmers." The agricultural practices are often primitive, but in many cases very progressive. The work of plowing and of cultivation is done principally with oxen, altho mules are now being tried on a small scale. Fertilization consists in applications of the native Peruvian Guano which is gathered on the Coastal Islands especially and of nitrate of soda coming from the mines which formerly belonged to Peru. The irrigation water is controlled very carefully so as to check the growth of weeds and to promote the growth and fruiting of the cotton plants at critical periods.

The principal variety of cotton grown in the central Peruvian valleys is known as Tanguis. This appears to have originated as a natural hybrid between some Egyptian type and an American upland type of cotton. The dominant characteristics are Egyptian. The original selection was made by Sr. Fermin Tanguis, and he has continued mass selection work more or less systematically during the past twelve or fourteen years. This variety now appears to be entirely wilt resistant and is a good strong growing and fairly closely fruiting plant. The type of growth during the first year after planting is quite erect but with two or three heavy vegetative branches near the base where the spacing is wide. Such stalks bearing more than one hundred and fifty (150) matured bolls are common. As many as 420 mature bolls have been produced on a single stalk of stubble cotton.

In Peru under tropical climatic conditions, with winter temperatures rarely falling below fifty degrees (50°F.), the cotton roots are not killed. Therefore after the crop is harvested, the stalks are cut back close to the surface of the ground. At the proper season the irrigation water is turned on and new growth starts. The crop thus produced from new sprouts may equal that of the first season from planting, and from three to seven successive crops may be grown in this way from one planting of seed.

During the field studies and from conferences with planters from widely separated sections, we found no evidence of the occurrence of the Mexican cotton boll weevil (*Anthonomus grandis* Boh.) or of the pink boll worm (*Pectinophora gossypiella* Saund.) which are generally considered as being the two most serious insect enemies of cotton.

Cotton Leaf Worms

However, Peru is not without its fair share of cotton pests. The most serious species found was undoubtedly one of the cotton leaf worms which has been determined for me by Dr. William Schaus as being *Anomis impasta* Guen. It is quite possible that two species of the genus Anomis occur on cotton in Peru, as local Entomologists identified the species as *Anomis luridula* Guen. In any case these leaf worms appear to be native species, widely distributed and now so well established that stripping of foliage is expected each season and the worms require treatment through a period of about three months. In the northern part of Peru our common species of leaf worm, *Alabama argillacea*, is reported as occurring also.

The genus Anomis is very closely related to Alabama. As might be expected, therefore, the general facts of life history, etc., appear to be very similar. Such observations as were possible on *Anomis impasta* indicated an egg stage of about three to five days; larval stage twelve to fifteen days and pupal stage seven to ten days. The total developmental period covering twenty-two to thirty days, as a rule, is quite similar to that for *Alabama argillacea* in the Cotton Belt. Portions of two generations were observed between February 20 and March 20, 1926. Reports from growers indicate the occurrence of four or more generations during the season in the same locality. This impression is confirmed also by the general practice of making three poison applications for the control of these worms. The attack appears to be rather concentrated upon late-planted, tender cotton. The species was found distributed from sea level to an elevation of more than two thousand (2,000) feet.

This native leaf worm species appears to have a number of predaceous and of parasitic enemies. These help to check the multiplication but are not effective enough to render poisoning unnecessary. The general poisoning practice which has prevailed for many years consists in the use of knapsack spray pumps, operated by Indians who do nothing else for a period of three months but apply this spray of arsenate of lead or calcium arsenate. The spraying done was very slow and unsatisfactory. The tops of the plants particularly where they exceeded four feet in height were never thoroughly covered. Therefore, many of the worms were not killed by the spray applications and succeeding generations increased steadily in abundance and destructiveness.

The substitution of dusting for spraying was advised and many planters were shown how to make the improved form of "pole and bag outfit" which has come to be used here. The saving in labor of application and the increase in the degree of control obtained were very striking in favor of the dust. Climatic conditions are ideal for such work as there is no rain to wash the poison from the plants. In some cases our type of cotton dusting saddle guns were used but they preferred to strap these over the shoulders of an Indian who walked through the rows rather than to drive a horse through and break many branches of the cotton. The entire situation in Peru indicated the advisability of providing for airplane dusting service for leaf worm control which has proven sosatisfactory here in the United States. Accordingly, at the request of leading cotton planters and with the official approval of the Peruvian Government, arrangements were made with the Huff Daland Dusters, Inc., of Louisiana to establish a similar service for Peruvian planters. In December, 1926, a staff of seven men with three dusting planes sailed for Peru and are now initiating there this advanced type of leaf worm control work. It is reasonable to suppose that the widespread, repeated and uniform applications of calcium arsenate distributed from airplanes will accomplish a far more satisfactory and profitable control of leaf worms in Peru than has heretofore been possible. This work may also serve to control in considerable measure some of the other important cotton pests beside the leaf worms.

THE PERUVIAN COTTON SQUARE WEEVIL
(*Anthonomus vestitus* Boh.)

This weevil was described in 1859 but nothing was known of its host relationships and economic importance until 1910 when Dr. C. H. T. Townsend working in northern Peru found that the species was breeding in cotton squares. This discovery was made at about 2° south latitude and not far from the small island off the coast of Equador where the first specimens were taken. The writer was working some six hundred (600) miles further south and found these weevils common in practically every field examined and ranging from sea level to an elevation of about two thousand (2,000) feet. Dr. Townsend expressed the conviction that the species would be found in all cotton-growing sections of Peru but stated that he had not found the species in Brazilian cotton fields. There is no positive record of its occurrence outside of Equador and Peru. The economic importance of the species within this area has not been fully determined, but it certainly does not equal the Mexican cotton boll weevil in destructiveness.

The Peruvian cotton square weevil resembles the Mexican cotton boll weevil in general shape but is very much smaller in size. Adults range from about 2.5 to 4 mm. in length. They are of a light brown or tan color where the scale covering has not been removed. The description "pisceous" as given by Pierce appears to be misleading altho the integument is brown in color. The adults are very inconspicuous in appearance, shy and very active. They run, take flight or drop much more readily than does our boll weevil and, therefore, adults are rarely seen in the field. The species breeds almost exclusively in squares that are less than one-half inch in diameter. Only the very small bolls are ever attacked. Evidently larger squares and even half-grown bolls cannot be penetrated for successful oviposition. The place of oviposition on squares is usually in the constricted basal portion so that the egg is placed in the base of a petal rather than among the pollen sacs. At that point proliferation forms more readily and produces a characteristic bulge just above the egg puncture but the "wart" that marks boll weevil punctures is not formed. The infested squares fall to the ground more quickly after oviposition than do those attacked by the boll weevil. The developing larvae and pupae appear to be more resistant than the boll weevil to heat and drought. Practically no dead weevils were found in fallen squares even where the ground was very dry and exposed to the sunshine.

The presence of the Peruvian cotton square weevil is indicated first, and always most plainly, by the flaring of squares. In one case, twenty-five punctured squares were found on a single plant and appeared to be the work of a single female. Usually, however, not more than six or eight punctured squares are found on a plant. As a general thing it does not seem likely that this species, although serious, will ever do more than one-half as much damage to cotton as does the boll weevil. It appears that the species is probably strictly tropical but we have no evidence at the present time to indicate whether it can or cannot survive freezing temperature during its hibernation period.

Boll-Boring Lepidopterons

While no pink boll worm specimens were found and we believe that none yet occur in Peru, we did find some four different species of small size Lepidopterous larvae boring into cotton bolls. Among these and occurring particularly in the decaying corollas of unshed blooms and in decaying bolls also, was a species which appeared to be our common *Pyroderces rileyi* Wals., known to us commonly as the pink corn worm or false pink boll worm. In a majority of cases this species appeared to be feeding as a scavenger but it was quite evident that its activity served to increase the proportion of old corollas which remained attached to the tips of the bolls. After working in such corollas it seemed that the larvae sometimes also bored directly in the sound boll tissue beneath the corolla, thus causing a direct primary injury to the growing boll. This matter calls for additional investigation as there is a possibility of two species which are very close in their resemblance having been confused in these hurried observations.

Two or three other small Lepidoperous larvae (species undertermined) were found commonly boring into bolls. These larvae were from one-half to five-eights inch long when full-grown. Unfortunately there was not sufficient time available for breeding out these species. Still another species resembling rather closely our cotton boll worm in size and in its feeding work was found only rarely.

The work of these caterpillars was frequently followed by the development of fungus diseases or boll rots of different types which often cause complete destruction of the boll. One larva appeared to enter the boll by preference at the very tip and its entrance was followed by a cracking open of the immature boll with complete loss. In some fields the owners felt that the crop was almost a complete failure because of the work of these larvae. A rather close examination, however, indicated that not more than 20% to 25% of the total crop was being destroyed by this agency. Some of these larvae attack squares as well as bolls.

COTTON PLANT LICE

While no case of extreme damage by a plant louse species was observed directly, reports from numerous planters indicated that earlier in the season, at about the time that squares began to form, heavy infestation with some plant louse species was common. This attack dwarfs the plants and is likely to interfere with the stand. Apparently sooty mold (referred to by the Spanish as the "black melasa") forms abundantly and adds to the damage done directly by the feeding of the lice. Up to this time there has been no attempt to control these plant lice. It is probable that some effort will be made in the near future to control this pest by applying nicotine sulphate and hydrated lime dust.

AN INTERESTING APHID OF THE PECAN

By THEO. L. BISSELL, *Assistant Entomologist, U. S. Department of Agriculture*

ABSTRACT

An aphid, *Myzocallis fumipennellus* F., injures pecan foliage in several sections of the pecan belt, including southern Georgia. The species is marked by its dark color, prominent tubercles and the effect of its feeding on the leaves. Around the puncture of a nymph appears a yellow spot which turns brown. Spots are identified by a rectangular effect and a dark margin. Heavy infestation may cause defoliation.

Of several aphids known to live on the pecan, one species, *Myzocallis fumipennellus* Fitch, may be considered of economic importance. During 1926 and 1927 considerable injury caused by this insect has been observed in orchards of southern Georgia. It is known to be of more or less importance in several sections of the pecan belt from Texas to North Carolina. Only once[1] has the species been mentioned in economic literature.

Published accounts give as the range of this aphid New York,[2] Illinois and Missouri[3] and North Carolina,[1] to which the author adds the District of Columbia,[4] Georgia, Florida, Louisiana and Texas. Fitch[2] and Davis[3] record it on hickory. Budded pecans are preferred in southern Georgia, although seedlings and at least two other species of *Hicoria* act as hosts. Of cultivated pecans in Georgia and Florida, the Stuart and Schley are attacked more than some other varieties.

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[1] Leiby, R. W. 1925. Insect Enemies of the Pecan in North Carolina, N. C. Dept. Agr. Bul., Feb., 1925, pp. 67. (p. 37).

[2] Fitch, Asa. 1855. (First) Report on the Noxious, Beneficial, and Other Insects of the State of New York, Albany, pp. 176. (p. 166).

[3] Davis, J. J. 1910. Two Curious Species of Aphididae from Illinois, Ent. News, Vol. 21, pp. 195-200, pl. VIII. (p. 198, *Callipterus caryaefoliae* n. sp., Synonym).

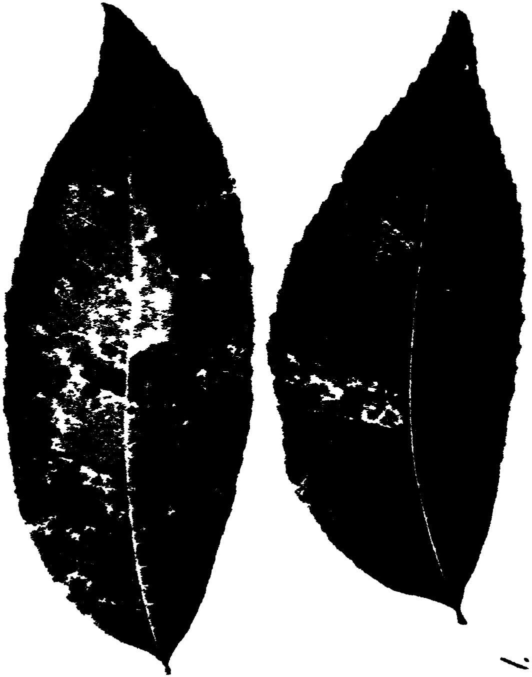
[4] Pergande, Theo. Unpublished record. From material in the U. S. Nat. Museum collected by Pergande in 1897 and 1908.

Myzocallis fumipennellus F. is a rather short, robust aphid, the largest individuals measuring approximately 1½ mm. by 1 mm., and is of striking appearance. The body color is pale brown or olive green, but dark brown tubercles and other heavily chitinized parts give an impression of black. Wax secreted from several points on the dorsum makes a regular pattern of white dots (not apparent in specimens mounted in balsam). The wings are clear with brown veins. Fourteen pairs of tubercles varying greatly in size give the back and sides an uneven surface. The outstanding feature of this insect is its dark color, and accordingly it might be called the "Black pecan aphid."

As to its habits, the aphid is found on the lower surfaces of leaves, occasionally on the upper surfaces and rarely on the nuts. Hardened leaves are preferred for feeding to those newly opened. It has been noted that trees beside a building are apt to be more heavily infested than those growing at a distance. The adults are fairly active and leap when disturbed.

An especially interesting characteristic of this *Myzocallis* is the peculiar effect of its feeding on the leaves. Two to four days (in July) after a nymph commences feeding a pale yellow area develops around the puncture. The area enlarges and becomes more intense in color until in four to seven days after the first feeding it is bright yellow shading into the leaf green on the edge and covers approximately 0.5 sq. cm. of surface. (See Pl. 14, fig. 1.) The effect spreads irregularly in all directions from the puncture and goes through the leaf tissue so that its extent is the same on both sides. The color is more intense on the upper surface, whether the aphid feeds from above or from below, because the upper surface is smoother than the lower. The discolored area is limited in part by primary veins which make it roughly rectangular. About the time an injured portion ceases to enlarge it gradually turns brown, starting at the feeding puncture. The margin usually becomes dark brown to black. All of the injury does not change, as an indefinite yellow border remains against the green. The brown area shrinks or warps and causes the leaf to curl. The square effect and the dark margin help to distinguish the injury from brown spots due to other causes.

If the infestation is severe, defoliation may result. When aphids become quite numerous the yellow and dead areas merge and the leaflets wither and fall prematurely. Often a leaflet drops while a portion is still green. Rarely all of a compound leaf falls, first the leaflets and then the petiole.



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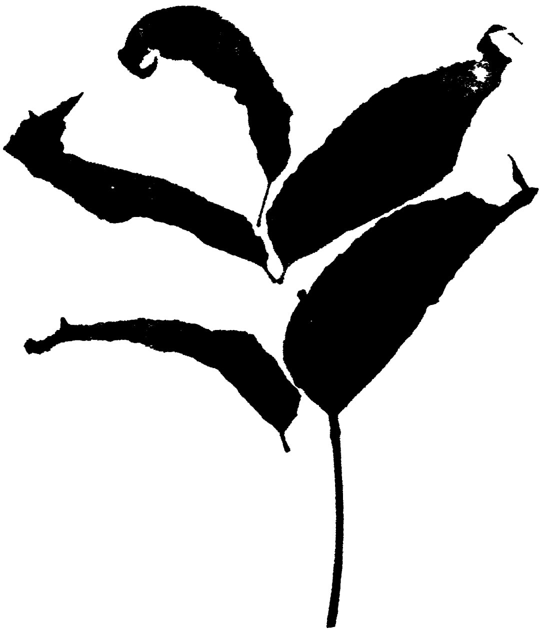

2.

1 — Effect of *Myzocallis fumipennellus* F on pecan (slightly reduced). 2 — Injured areas on leaflets, upper leaflet curling, lower leaflet with less advanced injury. Defoliation caused by aphids on a caged leaf

Figure 2, plate 14, shows a part of a pecan leaf on which was caged a colony of *Myzocallis* on August 28. On September 17 the cage was removed and the leaf photographed. The leaflets (five) which are shown in their respective positions by the petiole were affected as follows: Three had withered and dropped; one partly green had dropped; one partly green was still attached. Aphids can be seen on the two last. No record was made of the number of aphids in the cage but by examining the photograph the number of individuals present is estimated to be 500. A similar effect was produced in three other cages run at the same time under like conditions while the leaflets in a fifth cage run without aphids (check) were unchanged at the close of the experiment.

It is difficult to evaluate the damage caused by the black pecan aphid because the nut is not directly injured. It is possible that there is a check on tree growth by the reduction of active leaf surface which would have an indirect influence on nut production.

From the author's observations this insect does not become abundant until midsummer. One isolated tree was found to be noticeably infested about the middle of June, 1926, but no general infestation was seen in orchards till the last of July. By late August, 1925, trees in some sections were quite brown and leaves were falling, defoliation becoming marked in the month of September. In the year 1926 there was less defoliation, which might be explained by the pronounced difference in weather conditions. The temperature for 1925 was far above the average and precipitation was somewhat low, while in 1926 temperatures were a little below normal and rainfall was well above.

THE RELATION OF LEAF COLOR AND LEAF SIZE TO BOLL WEEVIL INFESTATION[1]

By DWIGHT ISELY, *Department of Entomology, University of Arkansas.*

ABSTRACT

Field experiments in 1925 and 1926 indicate that the boll weevil has a marked preference for cotton plants with green foliage to those with red foliage.

The boll weevil apparently has little choice between small leafed and large leafed varieties, provided the size and vigor of the plants is about the same.

The relation of two leaf characters, color and size of the leaf surface, to abundance of the cotton boll weevil was studied in a series of experiments carried on at the Arkansas Experiment Station farm at Fayetteville, in 1925 and 1926. The relation of other vegetative factors to the degree of boll weevil infestation has received considerable attention previously from other investigators, particularly from Cook[2]. It is well established that a heavy foliage is favorable to the weevil. On this basis, it is assumed by many cotton growers and some cotton breeders that plants with relatively small or deeply cut leaves are less susceptible to boll weevil injury than plants with large leaves. Accordingly, this leaf character is regarded by some plant breeders as a desirable one to develop. However, as far as I know, this has never been given experimental trial previously. Color characters also have apparently received little serious attention.

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[1] Reseach Paper No. 95, Journal Series, University of Arkansas.

These studies of the relation of leaf characters of cotton to the boll weevil were undertaken incidentally, along with studies of dispersion in an isolated cotton field on the Experiment Station farm. Fayetteville is on the northern slope of the Ozarks and is about forty miles north of what is usually considered the northern limits of the cotton belt. However, there is a small acreage of cotton grown in the Fayetteville vicinity, and since 1921 the boll weevil has been established in this territory. No other cotton was grown near the field in question, however, and consequently it was unaffected by weevils migrating in from other fields, until near the end of the season.

The results obtained are not significant from the economic point of view, but may be of interest to other entomologists, and may have some bearing on future experimental work. It may be stated at the outset that the results with both leaf characters in question were the opposite from that which had been expected.

The choice of varieties used in these experiments was based quite largely upon the recommendations of J. O. Ware, Cotton Specialist in the Agronomy Department. For contrasting leaf color, one variety used was Winesap, which has a dark wine red colored foliage. While the character of the lint and bolls has little to recommend it, the variety is fairly early and sets fruit rapidly. It is used in breeding experiments, but is not grown commercially, to any extent at least, in Arkansas. As a green leafed variety, one of the early northern grown strains of Acala was chosen, which was similar to Winesap in earliness and in rate of fruiting.

For comparison of leaf size, one series was of Okra Leafed Acala, a variety with deeply incised leaves resembling those of okra rather than cotton, contrasted with a strain of Lone Star from Texas with very large, broad leaves. The Okra Leafed Acala is not grown commercially in Arkansas. These two varieties were both relatively late. Another series contrasting two medium early varieties was used. As representative of the small leafed type, a strain of Lone Star from Northeastern Arkansas with foliage slightly larger than, but similar in form, to that of Trice, Express or Delfos was used. Mexican Big Boll, one of the largest leafed medium early fruiting varieties, was used for contrast. These two varieties do not represent as great a contrast in size of foliage as the Okra Leafed Acala—Lone Star (Texas) series, but the difference is about as great as could be secured by using commercial varieties with similar fruiting habits.

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[2] Cook, O. F. *1906.* Weevil-resisting adaptations of the cotton plant. U. S. D. A. Bur. Plant Indus. Bul. 88. 87 p. 10 pl.; *1911.* Relation of drought to weevil resistance in cotton. U. S. D. A. Bur. Plant Indus. Bul. 220. 30 p.; *1923.* Boll-weevil cotton in Texas. U. S. D. A. Bul. 1153, 20. p. Illus.

In 1925 these varieties were planted in series of six alternating plots, with rows 50 feet long. The series in which leaf size was contrasted were 20 rows wide. The plots in the color contrast series, from which little was expected, were only 10 rows wide. The arrangement of plots is shown in Table 1. In 1926 a somewhat different arrangement was used. In the Winesap-Acala combination, the varieties were planted in alternating plots in two adjacent series, of four plots each. However, in one series the odd numbered plots were Winesap, while in the other they were Acala, giving the plot arrangement a checkerboard effect. The Lone Star (Texas)—Okra Leafed Acala combination was also planted in two series similarly arranged. In view of the results of 1925, the Mexican Big Boll—Lone Star (Arkansas) combination was discarded. All rows were 50 feet long and all plots were 16 rows wide. The arrangement of the Winesap-Acala combination and one adjacent Lone Star (Texas)—Okra Leafed series is shown in Table 2.

In 1925 the cotton was planted on May 17 and 18, and all of the earlier varieties had begun setting squares by June 30. In 1926 cotton was planted May 16 and 17. On account of dry weather, germination was slower and setting of squares did not begin until about July 10. Weevils were not released in these plots until fruiting was well under way.

RED LEAFED VERSUS GREEN LEAFED COTTON

An apparent preference by the boll weevil for cotton plants with green foliage over those with red foliage was first noted by the writer in August of 1923, in a variety test carried on by the Agronomy Department on the branch experiment station farm at Scotts. The rows of Winesap cotton were in all cases distinctly less heavily infested than the adjacent rows of cotton with green foliage. A few weeks later after the late summer dispersion of weevils had taken place, all cotton red or green had about the same degree of infestation. Little significance was attached to the observation at the time.

The experiment in 1925 was confined to a series of three small plots of Winesap cotton alternating with three similar plots of Acala. Parallel with these plots on one side was a series of plots of green leafed cotton with about the same fruiting season. These varieties, Lone Star (Arkansas) and Mexican Big Boll, while intended for the leaf size experiment, were also used for comparison with the Winesap plots.

A total of sixty newly transformed weevils were released at a middle point in each of the Winesap and Acala plots. The first release was made on July 18 and the last was made on July 25. On each day when an infestation was released the same number of weevils were placed in each plot. By August 3, the infestation had spread practically over all six of these plots, and also into the adjacent series of green leafed cotton plots beside them.

Counts of the percentage of infested squares in each plot of the two series were made on August 14, 21, and 28. All counts of infestation were based on 200 squares taken in each plot. These percentages are shown in Table 1. In this table the Mexican Big Boll—Lone Star (Arkansas) series is designated as series F and the Winesap—Acala series is designated as series G. In series G, plots 2, 4, and 6 were red leafed cotton. It will be noted that while there was great variation in degree of infestation on the varieties with green foliage, yet on August 14 and 21 the plots of Winesap were in all cases less heavily infested than the adjacent plots. By August 28, as the infestation approached total, this difference began to decrease. The next week uninfested squares were rare on any variety and no counts were made.

TABLE 1. PERCENTAGE OF SQUARES INFESTED BY BOLL WEEVIL ON PLOTS OF RED-LEAFED COTTON, CONTRASTED WITH ADJACENT PLOTS OF GREEN-LEAFED VARIETIES, FAYETTEVILLE, ARKANSAS, 1925

Date	Series	Plot Number					
		1	2	3	4	5	6
August 14	F	25	46	15	16	12	38
	G	22	W 7	12	W 1	16	W10
August 21	F	69	78	56	63	56	64
	G	80	W33	63	W16	60	W26
August 28	F	77	77	79	66	66	59
	G	79	W50	63	W71	77	W44

W = Cotton with wine red foliage.

The arrangement of plots in the second season's comparison between red and green cotton made in 1926, is shown in Table 2. In this table is also shown the position of the adjacent plots of a solid green leafed series of Lone Star (Texas) and Okra Leafed Acala.

TABLE 2. ARRANGEMENT OF PLOTS IN TEST FOR COMPARISON OF RELATIVE ATTRACTIVENESS OF RED-LEAFED AND GREEN-LEAFED COTTON TO BOLL WEEVIL, FAYETTEVILLE, ARKANSAS, 1926

	Plot Numbers			
Series	1	2	3	4
D	Lone Star	Okra Leaf	Lone Star	Okra Leaf
E	Winesap	Acala	Winesap	Acala
F	Acala	Winesap	Acala	Winesap

Fifty newly transformed weevils were released on each of these plots between August 5 and 8. By August 17 they were fairly well spread over the plots and the first infestation counts were made. Subsequent counts were made on August 24 and 31. These percentages are shown in Table 3. In making infestation counts, 25 squares were taken from alternate rows of each plot, making a total of 200 to the plot. It will be noted that in spite of the variation in the degree of infestation in each of these plots, without exception the plots of Winesap were less heavily infested than the adjacent green leafed plots. The average infestation of the eight green leafed plots on August 17 was 43.87%; on August 24, 53.94%; on August 31, 58.62%. The average infestation on the four red leafed plots was on August 17, 14.25%; on August 24, 16.12%; and on August 31, 32.25%.

TABLE 3. PERCENTAGE OF SQUARES INFESTED BY THE BOLL WEEVIL ON PLOTS OF RED-LEAFED COTTON CONTRASTED WITH ADJACENT PLOTS OF GREEN-LEAFED VARIETIES, FAYETTEVILLE, ARKANSAS, 1926

Date of Infestation Counts	Series	Plot Numbers			
		1	2	3	4
August 17	D	41	49	46	16
	E	W15	79	W 8	54
	F	34	W24	32	W14
August 24	D	74	64	64	30
	E	W42	60	W18.5	41.5
	F	60	W31	35	W 5
August 31	D	80	71	60	42
	E	W50	58	W26	58
	F	53	W18	47	W35

W = Cotton with wine red foliage.

.. No explanation for the apparent preference for green leafed to red leafed cotton is offered, beyond a series of observations on the boll weevil's sense of color, by C. R. Jones in 1907, reported by Hunter and Pierce.[1] In this series of observations, weevils were given opportunity to enter tubes of different colors from a general box, and among the colors tested were green and red. Green was found to be more attractive than red at the rate of 6.0 to 3.8.

No economic importance can be attached at present to the apparent degree of immunity of red leafed cotton, since there is no red leafed variety which agronomists recommend for commercial planting. It is also possible, judging from the relatively even distribution of the weevil at the end of the season, over red and green plants alike, that this apparent immunity might disappear if the weevil had only red cotton for food.

SMALL LEAFED VERSUS LARGE LEAFED PLANTS

Between small leafed and large leafed varieties, the boll weevil apparently has little choice, judging from experiments in 1925 and 1926, at least if the size of the plants is about the same. Since the results of this experiment are largely negative, only a summary of results will be given. In 1925 only one infestation count was taken in the Okra Leaf—Lone Star (Texas) series. This count was made August 17, 20 days after the first release of weevils in these plots. Curiously enough, the Okra Leafed variety was more heavily infested than the broad leafed variety, the ratio being 33.50 for Okra Leaf to 22.50 for Lone Star. This was accounted for because the plants on one of the Okra Leafed plots were unusually luxuriant, due to more fertile soil, and on account of this inequality no more counts were made.

The infestation counts of the Mexican Big Boll—Lone Star (Arkansas) series have already been given in detail in Table 3. These counts showed the relatively small leafed Burdette Lone Star slightly more heavily infested on two dates than the broad leafed Mexican Big Boll. The summaries of infestation are: August 14—Lone Star (Arkansas), 33.33%; Mexican Big Boll, 20.33%. August 21—Lone Star (Arkansas), 68.33%; Mexican Big Boll, 60.33%; August 28—Lone Star (Arkansas), 66.67%; Mexican Big Boll, 71.33%.

In 1926, the broad leafed Lone Star (Texas) was slightly more heavily infested than the Okra Leafed Acala. The summaries of infestations are: August 17—Lone Star (Texas), 32.75%; Okra Leaf,

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[1] Hunter, W. D. and Pierce, W. D.—The Mexican cotton boll weevil. U. S. D. A. Bur. Ent. Bul. 114, p. 43. 1912.

29.75%. August 24—Lone Star (Texas), 57.75%; Okra Leaf, 41.12%. August 31—Lone Star (Texas), 70.00%; Okra Leaf, 66.00%.

The chief value of these negative results is that they differ from the popular belief and may eliminate one character which some plant breeders have considered. The elimination of this character may also be of value in future experimental work with boll weevil control.

IS THERE ANY DEFINITE BASIS FOR FORECASTING INSECT OUTBREAKS AND ASCERTAINING IF CONTROL MEASURES ARE PRACTICABLE?

A DISCUSSION FROM A RESEARCH STANDPOINT

By W. E. Hinds, Ph.D., *Entomologist, Louisiana Experiment Station and Extension Service*

The subject presented for discussion is certainly one of the most difficult, but at the same time, most practically important phases in many important insect control problems. Every such biological problem is exceedingly complex, and the important factors affecting it cannot be predicted with certainty. A careful investigation of the life history of any insect is likely to reveal the fact that different species respond in a different way to the same set of environmental conditions. The nature of this response must, therefore, be determined by a very careful and prolonged study of each important species.

Extended studies of particular species have been made with a number of our most important economic species, and where such is the case it is likely that the investigators concerned develop a fairly clear idea of the most evident important factors from a study of which they find that they are able to anticipate to some degree at least the prospective abundance of the species at the beginning of its development during the following season. Thereafter it will probably be true that the influence of climatic conditions which cannot be predicted through any long period of time are so important in their effect upon the multiplication or distribution of the species that the final abundance and extent of damage to any particular crop cannot be forecasted with any degree of accuracy at the beginning of the growing season. The rapid development of parasites or predators, or a very abrupt change in temperature conditions, or the occurrence of certain types of rainfall may change "prospects."

Perhaps the Extension workers in Entomology may appreciate the complexity of this problem if we merely enumerate some of the factors which are likely to be of importance in any such effort at "forecasting." The factors mentioned happen to be, in the main, some which have been found important with regard to the Mexican cotton boll weevil, with which the speaker has had rather extended experience.

It is important to know first of all, something as to the fall population of the species that is likely to enter hibernation. This study will involve records as to comparative abundance during a series of seasons. The abundance and favorable condition of the preferred fall food supply particularly is likely to be an important factor. The occurrence of early or late killing frosts in the fall affects the feeding, late fall multiplication of the species, the length of the hibernation period, etc. With the boll weevil the occurrence of still another cotton pest (the cotton leaf worm) which does not attack the boll weevil directly may have an all important influence upon this fall development of the species and the number of individuals, or the fall population, which may enter hibernation. The boll weevil has no other food plant than cotton, neither does the cotton leaf worm. When the leaf worm strips the cotton of its foliage, it causes the immediate cessation of growth and the shedding of all squares and small bolls which may be present on the stalks. In this way the leaf worm serves to check immediately and to a very important degree, the late fall multiplication of the boll weevil and often destroys its food supply so completely as to cause practically a wholesale destruction of the weevils before it is possible for them to hibernate successfully.

With many species, particularly Lepidoptera, the condition of parasitism in the fall may be of great importance and must be determined.

During the hibernation period of the species a group of factors that are important would include particularly, the abundance and accessibility of favorable hibernation shelter, the liability to destruction during its hibernation period by predators, etc. The amount and distribution of winter rainfall is likely to be important. Overflows, standing water, or even the movement of water may affect the survival of the species or its important natural enemies and may change the area of distribution to an important degree. For example, there seems now to be grave danger that through the occurrence of heavy winter rains in the infested area, corn stalks carrying hibernating European corn borer larvae may be washed into streams and drift long distances, distributing the species in this way. One of the most important winter factors is, of course, minimum temperature and if this falls unusually low or repeatedly reaches a point below the critical point for the insects, the percentage surviving the winter is likely to be very greatly reduced. Again, wide fluctuations in winter temperatures may be important as high temperature continuing for a considerable time may bring about a degree of activity on the part of the insect which will shorten its life or decrease its power of resistance through the balance of its hibernation.

In the spring group of factors, one of the first to be considered is the earliness of the season. This shortens the hibernation period and favors the development of the necessary food supply. In forecasting the early spring activity of a species, it is often possible to correlate the initial appearance or the beginning of breeding with some very plain common natural phenomenon such as the blooming or leafing of some particular kind of tree or plant. It is certainly much more difficult to estimate the factor of spring food supply when a species has a number of equally favorable host plants and if the species feeds upon a number of wild host plants.

With some species it is quite certain that hibernation cage experiments furnish a fairly good index as to the average percentage of survival under natural field conditions. This seems to be particularly true with the boll weevil and a great deal of such work has been done in connection with that species. Where the records are kept for a number of years an average, or normal, percentage of hibernation is ascertained and any unusual variation from this is noticeable. It has been found quite possible with the boll weevil to determine rather accurately the condition of initial infestation that may be expected, but it is not possible to go beyond this and forecast the development during the summer period which is ultimately the most important factor so far as damage by the pest is concerned.

In the summer group of factors, maximum temperatures are likely to be fully as important as winter minimum temperatures are. High heat, especially when continuing for prolonged periods, is almost invariably coincident with a period of unusual deficiency in rainful and the combination of heat and drought is a difficult one for many insects to endure. This is true particularly with the boll weevil during the first six weeks after squaring becomes common, as fully half of the development of the insect takes place after the square has fallen to the ground. If then the plants are not large enough to shade the major part of the ground area a majority of the insects are likely to be exposed to the direct sunshine and under conditions making it possible for the temperature at the surface of the ground to rise above 118 degrees F. which is approximately the critical maximum for this species. The Mexican bean beetle (*Epilachna corrupta*) is also subject to wholesale mortality of larvae and pupae during periods of extreme heat. With many other species, on the contrary, such a combination of conditions is not of critical significance. The insect may be able to move away from unfavorable conditions to those which it can endure, or the species may feed in the shade and well above the surface of the ground where the maximum temperature experienced is not nearly so high as at the surface of the ground in sunshine. Therefore, these factors must be studied for each particular species and may or may not be found to be of significance.

Summer rainfall may be important both in total amount and in the character of the rain. That is, it may make a vast amount of difference whether one inch of rainfall comes in a slow drizzle with little "drive" to it or whether the same amount of rain falls in large drops and driven by a heavy wind so that they strike with sufficient force to beat the foliage and to wash insects to the ground. Naturally a factor of this kind cannot be forecasted, but may be of extreme importance with such insects as plant lice.

Another summer factor is found in the number of generations produced by any species and in the rate of multiplication. These factors may be known with a high degree of accuracy based upon the average of observations on a large number of individuals. In this connection, normal or average mortality entirely apart from any artificial control effects must be considered. Theoretical multiplication possibilities are rarely borne out in actual experience. If this were not true, mankind would probably not be in existence on the earth today.

Many other considerations might be mentioned as bearing upon this problem of forecasting insect outbreaks, but probably enough has been said to indicate that there are great difficulties in the way of this ever becoming applicable to all economic species. Some may be susceptible to a fairly accurate forecasting and the experience of years may bear out such forecasts in a practical way. Other species, however, may present difficulties which cannot be overcome and the uncontrollable and unknowable factors may predominate so as to make forecasting an impossibility. This will probably be found true with a great many of the species which are rather sporadic in their occurrence and particularly those which are dependent upon migration through long distances during successive generations. In many cases, it is quite certain that the adults of winged species are carried for long distances by high air currents and the direction of their movement and the distance that they go cannot be foretold.

Undoubtedly there are many phases of insect multiplication studies to which the "Theory of Probability" may be applied and no doubt this will be done increasingly in the near future, but at the present time we do not see how this can be applied in a practical way to certain other phases of insect activity. Meantime the empirical test of practical experience may be our best guide and may prove to be of real service in many cases in meeting the problems of insect control most successfully.

REGIONAL COOPERATION IN EXTENSION ENTOMOLOGY

By ERNEST N. CORY, *State Entomologist College Park, Md.*

In every state there are certain problems in insect control that are identical with those in the adjacent states in many particulars. Of course, topographical and meteorological conditions vary and thereby modify the intensity of the infestations. Likewise, economic and sociological conditions determine the importance of many problems, but in the main, the problems of one state are usually the same for nearby states except in the isolated cases of infestation by imported pests.

It follows, therefore, that the method of attack in one state will be of the utmost interest to the workers in adjacent fields. No state has such a large force of entomologists engaged in research that it can supply all the ammunition that the extension worker requires. He must look to investigators in other states and Federal entomologists for much of the information he is expected to disseminate. Don't forget that the extension worker is supposed to be omniscient, omnipotent and omnipresent. In order to approximate the first attribute he must rely upon brief and inadequate contacts with his own experiment station workers, the annual meetings and a hurriedly gathered mass of new bulletins, thrust into his grip on his sporadic return to headquarters, to be read on a lurching bus or "rattler" as he goes from place to place in an attempt to be omnipresent. By the time he gets back to his office, a new crop of bulletins is at hand, some of which may upset the conclusions he has reached from his previous reading. No worker in the entomological field is so handicapped in subject matter as the extension entomologist, unless he confines his efforts to a limited field and then he lays himself open to the criticism that he is neglecting other crops or interests. Few states have the organization to serve every interest by specialists.

A partial remedy for these ills lies in regional cooperation in research and extension programs. The difficulties that beset cooperation in research are not insurmountable, if a broad concept of cooperation is kept in mind and an unselfish attitude towards one's co-workers is maintained.

It is perfectly possible and proper for investigators, in regions of similar conditions, working on the same problem of major interest to each state, to meet at frequent intervals for the purpose of familiarizing each other with the progress made, the difficulties encountered and the leads established or indicated. Such conferences tend to increase mutual respect, establish confidence and promote the work. This is not theory but is fact. It has been proved to the writer's satisfaction by the several conferences on the Cumberland-Shenandoah Region apple production problems, from which issued the joint spray program and the rosy aphis project; by the oriental fruit moth conference at Harrisburg, in 1926; by the potato tuber moth conferences in Virginia; by the many Japanese beetle and corn borer conferences and by others too numerous to mention. Conferences on research problems should be attended by extension workers whenever possible, as they would serve as his clearing house.

The foregoing relates to subject matter almost entirely. What of methods and administration? What sells any article of daily use? National advertising. The extension entomologist has something infinitely harder to sell and yet he sticks to local advertising. National advertising or, in other words, universal methods, are not possible maybe but the same methods used over a region of similar characteristics with essentially the same insect problem would most certainly have a greater chance of selling the idea than the efforts of an individual, uncoordinated with the other workers in adjacent states.

Regional cooperation, in its broadest sense, in research projects is an accomplished fact as evidenced by the attitude of the Federal Bureau of Entomology, and the more recent state activities. Regional cooperation in coordination of subject matter and methods has made a beginning, yet much more can be accomplished by whole-hearted cooperation in regions of similar problems. Insects disregard state lines. Why should we consider state lines in formulating our plans of attack? Is there any good reason why eleven states should each have different recommendations for the control of the Mexican bean beetle, when one plan, arranged in conference, would meet the situation and vastly increase the respect of the farming element, many of whom, especially those along the borders, get the publications of several states.

We stand at the threshold of a broader, more efficient extension program if we adopt generally the regional concept of cooperative endeavors and build up as rapidly as possible a body of recommendations that are identical, for regions where insect activities are comparable.

SOME RESULTS WITH BAIT PANS AGAINST THE ORIENTAL MOTH, *L. MOLESTA*, BUSCK

By J. R. STEAR, *Pennsylvania Bureau of Plant Industry, Chambersburg, Pa.*

ABSTRACT

Bait pan experiments over a two year period failed to give appreciable control. Tests with various methods of placing bait pans showed that while a pan in every tree gave the highest catch, a pan in every second tree caught almost as many.

Variation in the intervals of cleaning and adding molasses to the bait pans showed that a daily removal of insects and frequent additions of molasses resulted in the highest catch of adults.

Releases of marked adults in the bait pan plot showed a small percentage of recovery in the pans, the highest being 30% caught over a period of nine days after release.

From the data on control and the small percentage of released adults recovered it is concluded that bait pans offer little hope in practical control.

During 1926 and 1927 at Chambersburg, Pa., the writer tested out on a small scale, the effectiveness of bait pans in controlling the Oriental moth. The results obtained and some observations made in this connection are presented in this paper.

In 1926, three plots of Elberta peach trees were hung with bait pans as follows: Plot 1, a pan in every fourth tree; Plot 2, a pan in every tree; Plot 3, a pan in every other tree. (See below for plan of the plots.) Except that Plot 1 was interplanted with apples similar conditions prevailed for all three plots. Plot 1 contained 110 trees, 85 of which were peach, Plot 2 contained 99 trees and Plot 3, 98 trees all of which were peach. The plots were separated by five rows of check trees.

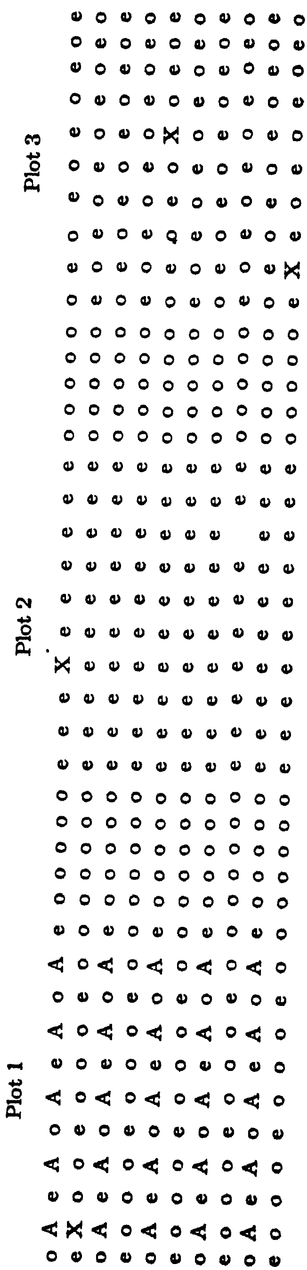
The containers used were half-gallon enameled stew pans. The bait used was stock molasses at the rate of one part to ten of water. The pans were examined daily except Sunday and all captured insects removed with a sieve. A tablespoonful of molasses was added twice a week to maintain the level of attractiveness and water added when necessary to keep fairly full.

Records were kept of the total catch in each plot for the season. Although the catches were rather light due largely to a total crop failure in 1925 and a small overwintering generation, the numbers taken in the different plots are of interest. See Table 1.

TABLE 1. L. MOLESTA ADULTS TAKEN IN BAIT PAN PLOTS

Plot No.	Bait pan arrangement	No. of pans	No. of trees	Total catch	Average per pan
1	A pan in every 4th tree	30	84	1024	34.1
2	A pan in every tree	99	99	1444	14.6
3	A pan in every 2nd tree	50	98	1386	27.7

PLAN OF BAIT PAN PLOTS IN 1926



A—Apple tree, o—Unbaited Peach Tree, e—Baited Peach tree, X—Missing Peach Tree.

The catch per plot varied with the number of pans. Plot No. 2 with a pan in every tree caught the greatest number and Plot No. 1 with a pan in every 4th tree caught the least. The catch per pan increased as the number of pans decreased but not in inverse ratio. Making corrections for the unequal number of trees in each plot and assuming the catch in plot No. 2 with a pan in every tree to be 100%, that of Plot No. 3 with a pan in every 2nd tree was 97% and that of Plot No. 1 with a pan in every 4th tree was 84%. The difference between the catch of Plot 2 and 3 was so small it does not appear to be any advantage to use more than a pan to every two trees. The difference in favor of a pan to every other tree over a pan to every 4th tree seems sufficient to justify using a pan to every other tree.

The infestation was very low in the Elberta block in 1926 and no difference in control was noted between the bait pan plots and the remainder of the block. Eight trees at the center of each plot and four check trees, 5 to 10 rows from the plots were used as count trees. The results are given in Table 2.

TABLE 2. ELBERTA COUNTS, BAIT PAN EXPERIMENT, 1926

Plot No.	Bait pan arrangement	Total fruit	No. wormy	% wormy
1	A pan in every 4th tree	5100	47	.9
2	A pan in every tree	5199	20	.38
3	A pan in every 2nd tree	5151	81	1.57
Checks	No pans	840	10	1.19

Although the Elbertas showed an average of less than 1% wormy fruit when harvested September 3rd, a nearby block of Salways picked on October 4th were 30% wormy. For further work with bait pans in 1927 it was decided to use the Salway block. A plot, 19 rows square was hung with bait pans in every other tree. Pans were hung in the orchard April 22nd and maintained until harvest. Refiner's syrup 1 to 10 was used in place of stock molasses. Otherwise the pans were cared for as in 1926 except for certain rows where the treatment was varied as noted later. Due to apple interplants and missing peach trees, the plot contained but 232 peach trees in which 156 pans were hung. A record of the total catch from the plot was not taken. The catches in the pans of two rows, G and K (see plan below) were recorded. These two rows with a total of 17 pans caught 2080 moths or an average of 122.2 moths per pan. Considering this catch to be average for the plot, about 19,000 adults were taken in the 156 pans.

A check up at harvest time on Sept. 29th failed to show any definite difference in favor of the bait pan plot over the check trees. Seven bait pan trees, six of which were in one row across the plot and five check trees were used as counts. Examination was external only except in the case of bait pan tree No. 4. The results are given in Table 3.

TABLE 3. SALWAY COUNTS, BAIT PAN EXPERIMENT, 1927

Bait pan plot	Total fruit	Apparently Wormy No.	Apparently Wormy %	Actually Wormy No.	Actually Wormy %
Tree 1	410	131	31.9		
" 2	608	181	29.7		
" 3	287	96	33.4		
" 4	206	52	25.2	118	57.2
" 5	273	77	28.2		
" 6	111	38	34.2		
" 7	198	52	26.2		
Checks					
Tree 1	167	83	49.7		
" 2	84	36	42.8		
" 3	182	56	30.7		
" 4	230	43	18.7		
" 5	113	11	9.7		

Average of bait pan plot—29.9% apparently wormy
" " checks —29.5% " "

A study of the table shows considerable variation in the percentage of wormy fruit but not consistently in favor of the bait pan plot. Checks No. 1 and 2 show a higher percentage of injury than the bait pan trees while checks 4 and 5 show a much smaller percentage. Figuring the average per cent for all of the checks and all the bait pan trees, the apparently wormy fruit amounts to about the same, being 29.5% for the checks and 29.9% for the bait pan trees. The checks (No. 1 and 2) that were nearest to the bait pan plot showed the greatest injury. They were in rows adjoining the bait pans where it would seem the pans would have some effect. The other checks, Nos. 3, 4 and 5, were located 11, 17 and 23 rows respectively from the bait pans. Check No. 5 the farthest away had the lowest injury and check No. 4 the next farthest away had the next lowest injury. Why this should be so is not very clear. It seems probable however that it is not due to any effect of the bait pans but rather to the location of the checks in the orchard. Checks No. 1 and 2 were at the edge of the Salway block adjoining the main part of the orchard while the other checks were thirty or forty rows away from the main part of the orchard in the interior of the Salway block.

In connection with the control experiment, work on methods of handling the bait pans was conducted. From May 28th until July 15th, eight rows of the control plot were handled as follows:

1st Series	Row G	Cleaned daily, syrup added twice a week.
	" H	Cleaned once a week, syrup added twice a week.
	" I	Cleaned once every two weeks, syrup added twice a week.
	" J	Cleaned once every month, syrup added twice a week.
2nd Series	" K	Cleaned daily, one tablespoonful of syrup twice a week.
	" M	Cleaned daily, one tablespoonful of syrup once a week.
	" N	Cleaned daily, one tablespoonful of syrup every two weeks.
	" O	Cleaned daily, one tablespoonful of syrup once a month.

In the case of the first series, records were kept of the Oriental moths on the surface only. Other than removing oriental moths from the surface, the pans in rows H, I and J were not disturbed except at the intervals designated. The pans in row G were cleaned daily but only the moths on the surface counted to make the records comparable. In both series, the pans cleaned daily and given syrup twice a week caught the most moths. See Table 4.

TABLE 4. COMPARISON OF METHODS OF HANDLING BAIT PANS

Series	Row	Bait pan treatment	No. of pans	Catch	Avg. per pan
1	G	Pans cleaned daily, syrup twice a week	9	331	36.7
	H	Pans cleaned once a week, syrup twice a week	8	129	16.1
	I	Pans cleaned every two weeks, syrup twice a week	9	224	24.9
	J	Pans cleaned once a month, syrup twice a week	8	148	18.5
2	K	Pans cleaned daily, syrup twice a week	8	344	43.
	M	Pans cleaned daily, syrup once a week	8	293	36.6
	N	Pans cleaned daily, syrup once every two weeks	8	211	26.3
	O	Pans cleaned daily, syrup once a month	8	152	19.

To determine the effectiveness of the pans in attracting moths and learn something of their movements in the orchard, releases of marked adults were made in the bait pan plot at three different times during the season. Newly emerged adults were placed in wire screen cages and the wings touched with a brush dipped in a solution of alcohol soluble eosin stain. If this is attempted in a glass cage, many moths become fast on the glass but in a screen cage with the open end away from the window the work may be done very quickly and without apparent injury to the moths. Water was supplied to the moths before they were released for fear that more than a normal number might be attracted to the pans through thirst.

On May 25th, 20 ♀s and 20 ♂s were released in the center of the bait pan plot. A few dropped to the ground but most of them flew into the air and were flying with the wind at a height of 8 to 10 feet, sufficient to clear the tops of the trees when last observed. They were in sight for perhaps 75 feet. Of these adults, 2 ♂s were recovered, one on the 28th and one on the 1st of June. One was taken in a tree adjoining the point of release and the other about 100 feet away. Weather conditions were very unfavorable following the release and the rather strong wind blowing at the time may have carried them out of the plot.

On August 16th, 40 ♀s and 30 ♂s were released as before. Of these adults, 11 ♀s and 10 ♂s were recovered over a period of 9 days following the release. This is 30% of the number released. Had the bait pan plot been more extensive, a greater percentage would likely have been recovered. As it was, many no doubt flew out of the plot.

A third release was made on October 4th. Conditions were unfavorable due to rain and of the 27 moths released, but 5 were recovered over a period of 4 days after release. A summary of the releases is given in Table 5.

TABLE 5. SUMMARY OF RELEASES AND CAPTURES OF *L. molesta* ADULTS

Release date	No. released	No. recovered	No. of days from release to last capture
May 28th	40	2	7
August 16th	70	21	9
October 4th	27	5	4

A plan of the plot is given below, showing the point of release and the location of pans catching moths with the numbers caught. Assuming that the highest percentage recovered is somewhere near the percentage taken of the entire moth population, it would seem that little help can be expected of bait pans, especially since many of those caught have time to deposit eggs first.

PLAN OF BAIT PAN PLOT SHOWING RECOVERY OF RELEASED MOTHS

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
0		0		0		0		0		03		0		0		0		01
	0		01		01		X		0		0		0		0		0	
0		0		0		X		0		0		01		0		0		0
	0		0		0		0		0		X		0		X		0	
0		0		0		0		0		0		X		0		0		0
	01		0		0		0		0		01		0		0		0	
0		0		0		0		0		01		0		0		X		0
	0		0		0		0		0		0		0		0		01	
0		01		0		0		X		X		0		0		X		0
	0		0		0		0		R		0		01		X		0	
0		0		0		0		02		X		01		0		0		X
	0		0		0		0		0		01		0		0		01	
X		X		0		0		0		0		0		0		0		0
	0		0		0		0		0		X		0		X		0	
0		0		0		0		0		0		0		0		X		0
	0		0		0		0		0		0		X		X		01	
0		0		0		0		0		0		0		X		0		0
	0		01		0		0		0		0		0		0		0	
X		0		0		0		0		01		X		X		0		0

R—Point of release. X—Missing peach trees. 0—Bait pans. The figure indicates the number of moths caught.

AN INVESTIGATION OF SPRAY COVERAGES AND ARSENICAL RESIDUE IN RELATION TO THE CONTROL OF THE CODLING MOTH[1]

By RALPH H. SMITH, *University of California, Citrus Experiment Station, Riverside, California.*

ABSTRACT

During the years from 1920 to 1927, inclusive, extensive laboratory studies with newly hatched codling moth larvae were made and various orchard experiments were performed for the purpose of securing data concerning the effectiveness of control in relation to such factors as: (1) type and character of the spray covering, whether fine-spotted, coarse-spotted, overspray or film; (2) thickness of the covering as revealed by the average amount of As_2O_3 per square centimeter of apple surface; (3) thoroughness of spray application and completeness of covering as revealed by the quantity of spray applied per cubic yard of tree volume; (4) quantity of lead arsenate per hundred gallons of water; (5) weathering off of the poison as revealed by repeated analyses during the season; (6) entrance habits of the newly hatched larva; (7) excessive arsenical residue on the fruit at harvest. An important feature of the in-

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[1] Paper No. 179. University of California, Graduate School of Tropical Agriculture and Citrus Experiment Station, Riverside, California. Submitted for publication December 20, 1927.

vestigation was the effort made to conduct the experiments with such preciseness as to eliminate to the greatest practicable degree the factors that might contribute to experimental error. The results of the investigation indicate, among other things, that the fine-spotted or "mist" coverage is decidedly the least protective of all, that the protectiveness of any type of coverage varies directly with the amount of arsenic per square centimeter of fruit surface, that the thickness of the film is an important limiting factor in the protectiveness of the film coverage, that overspraying of trees and the use of more lead arsenate than has been recommended in the past are advisable if the maximum effectiveness of the spray is desired, that the completeness of coverage and the amount of arsenic deposited on the fruit vary directly, within certain limits, with the quantity of spray applied per cubic yard of tree volume, that a large percentage of larvae enter the apples unharmed or produce serious injury to the fruit by burrowing directly through the deposit of lead arsenate, and that the efficacy of arsenical sprays in protecting apples against the codling moth has been generally overestimated. Bibliography of 40 titles.

The investigation which this paper briefly summarizes originated in the summer of 1920 when in the course of inspecting an orchard that had been sprayed with calcium caseinate spreader and lead arsenate the writer first observed definite instances in which codling moth larvae had entered apples directly through a film of the poison. The fact that the larvae could do this was at once regarded as a matter of unusual significance because it indicated that the thickness of the spray covering, as well as the completeness of the covering, was a factor in codling moth control. Coincidently, the apple industry in the western states was experiencing considerable commotion as a result of the condemnation of fruit during the previous year on account of excessive arsenical residue. An investigation was outlined, therefore, for the purpose of securing information among other things on such points as (*a*)completeness of spray coverage, (*b*) durability of spray coverage, (*c*) thickness of the spreader film and (*d*) quantity of arsenic on the fruit in relation to the efficacy of lead arsenate in protecting apples against codling moth injury and, also, in relation to excessive arsenical residue on harvested fruit.

EXPERIMENTS AND OBSERVATIONS MADE IN 1921 AND 1922

Many data were secured as a result of analyses of spray residue made with the cooperation of Prof. Ray E. Neidig at the University of Idaho, and as a result of orchard and laboratory experiments conducted during the year 1921, but those data are now considered of minor importance in comparison with the results obtained from more careful and much more exhaustive studies subsequently conducted. One phase of this first work, which deserves special mention, consisted of applying fine-spotted and film coverages of lead arsenate in amounts of 1 lb., 2 lb. and

3 lb. to 100 gal. of water, to nearly mature apples; the spray being applied with a small atomizer.[2] A total of one hundred eight newly hatched codling moth larvae were placed on twelve apples with the average result that 26% of the larvae entered through the fine-spotted coverage and 18% entered through the film coverage. The fact that larvae could enter apples thus ideally covered with spray was so contrary to the dictum which had prevailed generally from the early use of arsenicals in codling moth control that, after discussing the matter with an esteemed friend and former teacher in entomology, I became skeptical as to the reliability of the data. It was suspected that the lead arsenate might have been of a very poor quality. Although Card (5, p. 19, 20), Slingerland (24, p. 20, 56, 57), Simpson (23, p. 32, 88) and Sevastjanov (21) had made observations on the fact that the newly hatched larva rejects the skin of the apple, and Melander (14), (15), (17), also had remarked concerning this behavior, these authorities either definitely stated or left ground for the belief that larvae entering through a distinct deposit of arsenical compound would secure sufficient posion eventually to kill them; at least, during the time that lead arsenate had been in general use, apparently no one had opposed the tenet prevailing universally that the occurrence of wormy apples in sprayed orchards was the result of larvae entering the fruit before the spray was applied or entering at places not actually covered with the insecticide.

The fact that in the experiment above mentioned a much smaller percentage of the larvae entered through the film coverage and that this result was in agreement with the outcome of certain orchard tests conducted in 1921 (25, p. 204), was considered substantial proof that the use of the spreader would result in improved control of the codling moth.[3]

Much to the surprise of many persons, including the writer, the general commercial use of calcium cascinate spreader during 1922 failed to give the marked improvement in codling moth control that was expected. Various possible causes were advanced for this failure, among them being the following: (*a*) that the casein acted as an antidote to the arsenic, (*b*) that the film of poison broke owing to the growth of the fruit and the worms entered at the resultant unprotected areas, (*c*) that the lime in the spreader constituted a diluent which lowered the poisonous value of the lead arsenate, (*d*) that the spreader did not improve the completeness of the spray covering, (*e*) that the film of poison produced by the spreader was too thin.

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[2] "Indestructible" atomizer, purchased of F. Weber Co., Philadelphia.

[3] Subsequent investigations, mentioned in the present paper, demonstrated that the fine-spotted coverage was very much less protective than the coverage of coarse spots, contrary to the belief that had generally prevailed. Therefore, in the experiments made in 1921, the film coverage was compared with the least effective type of spotted coverage, instead of the best as was then supposed.

ORCHARD AND LABORATORY EXPERIMENTS IN 1923 AND 1924

Although experiments were undertaken to secure information on each of the above points, special investigations were made on the thickness of the spray covering. During 1923 orchard experiments in using powdered acid lead arsenate at 2 lb. and 4 lb. to 100 gal. of water, with and without calcium caseinate spreader, were conducted with the cooperation of Prof. J. H. Newton (20) in the Grand Valley of Colorado, where the codling moth occurs in unusual abundance; and similar tests were made under my supervision by twelve leading apple growers in Idaho, Washington, Oregon and California. All trees received drenching quantities of spray. In all of these tests the spray containing four pounds of lead arsenate to 100 gallons of water gave better control than that containing two pounds. On the whole, the spreader resulted in slightly better control than the spray without the spreader, with lead arsenate at 4 lb. to 100 gallons.

During July and August,' 1923, laboratory studies were conducted in which over ten thousand newly hatched codling moth larvae, about half of them being from eggs supplied by Mr. W. P. Yetter, Jr., from his insectary at Grand Junction, Colorado (39, p. 32), and the rest secured from Santa Clara and Sonoma Counties, California, were placed on sprayed apples having their calyx cavities previously filled with shellac. The apples were sprayed in the laboratory, compressed air being used to operate the same atomizer employed in the tests of 1921.

Powdered acid lead arsenate was used in amounts of ½, 2, 4 and 8 lb. to 100 gal. of water. Experiments were made with four types of coverages; namely, fine-spotted or "mist," coarse-spotted, overspray and film. Calcium caseinate spreader was used to effect the film coverage. In order to have an estimate of the thickness of the covering of lead arsenate, the surface area of each apple was computed and at the end of the experiments analyses were made to ascertain the average amount of arsenic per square centimeter of apple surface.[4]

The results of the above experiments were reported at several meet-

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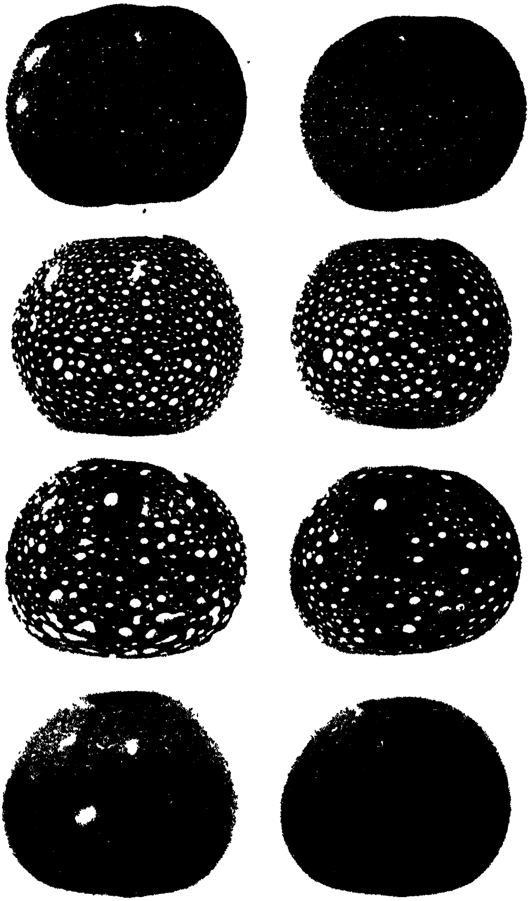
[4] The methods and technique employed in the experiments are fully described in Hilgardia (Calif. Agr. Exp. Sta.) Vol. 1, No. 17, 1926.

Plate 15



The four types of spray coverages referred to in this article. From top to bottom: film coverage, overspray coverage, coarse-spotted coverage, fine-spotted coverage. Left, apples that received a single application of spray in the laboratory; right, the same apples after receiving a second application of spray. There was a tendency for the drops of the second application to form on the deposits of the first.

ings[5] and were discussed with a score or more persons of recognized authority on spraying and codling moth control; and the general attitude of those persons was that the findings needed further verification. Under the circumstances the laboratory experiments, supplemented by certain technical orchard tests, were repeated on a still larger scale and with added refinements in technique at the University of California during July and August, 1924. The results, which have been published in detail (31), were essentially the same as those obtained the previous year.[6] The outstanding facts, as indicated by the accompanying graphs, were that (*a*) the lead arsenate was far less effective in protecting the apples than theretofore had been believed; (*b*) the fine-spotted coverage proved to be decidedly inferior to the coarse-spotted coverage; (*c*) at the usual concentration of 2 lb. of lead arsenate to 100 gal. of water, the film coverage gave about the same protection as the coarse-spotted coverage; (*d*) in all of the coverages the protection varied directly with the thickness of the poison covering.

EVALUATION OF THE EXPERIMENTAL DATA

A considerable part of the year 1925 was spent in reviewing more carefully than previously the literature on codling moth control and in making orchard observations in various localities in California and Oregon, for the purpose of reaching a conclusion regarding the relation of the data obtained in the research above mentioned to the practical control of the codling moth in apple orchards. Finally, a series of articles were prepared for publication which contained among other carefully weighed statements, the following: "The efficacy of lead arsenate in protecting apples against injury *has been overestimated*" (29, p. 6); "the recommendation that apples should be covered with fine particles of spray is based on theory, and the theory is erroneous" (34, p. 7); "The more poison on the leaves, bark and apples, the more worms will be killed . . . if worms are bad it will pay well to double the amount of poison" (34, p. 7). Overspraying was advised if the maximum effectiveness of the spray was needed.[7] The practical appli-

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[5] Among the meetings were the Fifth Annual Conference of Northwestern Horticulturists, Entomologists and Plant Pathologists at Boise, Idaho, July, 1923; the annual meeting of the Connecticut Pomological Society at Hartford, Conn., November, 1923; the Farmers' and Fruit Growers' Institute at Provo, Utah, January, 1924; the annual meeting of the Pacific Division of the A.A.A.S. at Stanford University, Calif., June, 1924 (26).

[6] The experiments of 1923 were performed in the laboratories of the Golden State Milk Products Company, San Francisco. Mr. Henry W. Dixon of Berkeley, Calif., assisted with the work, especially with the arsenic determinations.

[7] See also bibliographical references (28) (32) (33) (35) (36).

TABLE 1. SHOWING THE AVERAGE SURFACE AREA PER APPLE, THE AVERAGE MILLIGRAMS OF As_2O_3 PER APPLE, THE AVERAGE MICROGRAMS (µg.) PER SQUARE CENTIMETER OF APPLE SURFACE, AND THE AVERAGE GRAINS OF As_2O_3 PER POUND OF APPLES AS ASCERTAINED BY MEASUREMENTS AND ANALYSES MADE BEFORE AND AFTER EACH COVER SPRAY AND AT HARVEST. THE TABLE ALSO SHOWS THE AVERAGE MICROGRAMS OF As_2O_3 IN THE OUTER AND THE INNER CALYX CUPS, AND THE PERCENTAGE OF APPLES INJURED BY WORMS IN THE BLOCKS OF APPLE TREES RECEIVING DIFFERENT SPRAY TREATMENTS

		BLOCK 1				BLOCK 2			
		1st calyx spray, lead arsenate 2½ lb.–100 gal. 2nd calyx spray, lead arsenate 2½ lb.–100 gal. 5 cover sprays, lead arsenate 4 lb.–100 gal. and hydrated lime[1] 1 lb.–100 gal.				1st calyx spray, lead arsenate 2½ lb.–100 gal. 2nd calyx spray, lead arsenate 2½ lb.–100 gals. 5 cover sprays, lead arsenate 3 lb.–100 gal. and fish oil[2] ½ gal.–100 gal.			
Time of making analyses		Area per apple sq. cm.	As_2O_3 per apple mg.	As_2O_3 per sq. cm. µg	As_2O_3 per pound grains	Area per apple sq. cm.	As_2O_3 per apple mg.	As_2O_3 per sq. cm. µg.	As_2O_3 per pound grains
Before 2nd cover spray	May 18	32.2	.09	2.8	.037	32.2	.125	3.8	.054
After 2nd cover spray	May 19	38.8	.375	9.1	.113	34.2	.385	11.2	.158
Before 3rd cover spray	June 3	45.4	.185	4.1	.044	50.2	.262	5.2	.059
After 3rd cover spray	June 5	47.8	.650	13.7	.152	45.4	.588	12.9	.152
Before 4th cover spray	July 7	91.6	.656	7.2	.052	88.2	.532	6.1	.052
After 4th cover spray	July 10	95.0	1.186	12.5	.103	95.0	1.338	10.9	.092
Before 5th cover spray	July 29	116.8	1.226	10.4	.079	116.8	1.061	9.1	.068
After 5th cover spray	July 30	120.8	1.572	13.0	.076	128.7	1.898	15.2	.073
At harvest	Sept. 14	144.3	.690	4.8	.032	132.7	1.212	9.1	.067
Average		81.4	.737	8.6	.076	80.3	.822	9.3	.086
As_2O_3 in calyx:									
Inner cup, µg.			4.7				3.3		
Outer cup, µg.			19.3				23.3		
Total			24.0				26.6		
Percentage of apples injured by worms			35.3				32.7		

[1] The brand of lead arsenate used in this test contained a small quantity of casein to improve the spreading of the spray. The manufacturer recommended adding hydrated lime, this serving to dissolve the casein.

[2] This was a rather crude grade of fish oil. It was added to improve the spreading and sticking quality of the spray.

Time of making analyses		Block 3				Block 4			
		1st calyx spray, lead arsenate 2½ lb.–100 gal. 2nd calyx spray, lead arsenate 2 lb.–100 gal. 5 cover sprays, lead arsenate 4 lb.–100 gal. and calcium caseinate[3] 1 lb.–100 gal.				1st calyx spray, lead arsenate 2 lb.–100 gal. Triona[4] 2½ gal.–100 gal. and calcium caseinate 1 lb.–100 gal. 2nd calyx spray, same as first calyx spray. 5 cover sprays, same as first calyx spray.			
		Area per apple sq. cm.	As_2O_3 per apple mg.	As_2O_3 per sq. cm. µg.	As_2O_3 per pound grains	Area per apple sq. cm.	As_2O_3 per apple mg.	As_2O_3 per sq. cm. µg.	As_2O_3 per pound grains
Before 2nd cover spray	May 18	36.3	.112	3.1	.036	36.3	.130	3.6	.041
After 2nd cover spray	May 19	34.2	.325	9.1	.129	34.2	.251	7.4	.089
Before 3rd cover spray	June 3	47.8	.270	5.6	.063	45.4	.226	5.0	.054
After 3rd cover spray	June 5	45.4	.431	9.5	.117	43.0	.374	8.9	.086
Before 4th cover spray	July 7	98.5	.576	5.9	.049	81.7	.512	6.3	.055
After 4th cover pray	July 10	88.2	1.064	12.3	.104	91.6	1.086	11.9	.099
Before 5th cover spray	July 29	120.8	1.050	8.7	.066	120.8	.871	7.2	.058
After 5th cover spray	July 30	132.7	1.810	13.9	.105	128.7	1.618	12.9	.095
At harvest	Sept. 14	149.8	.905	6.1	.042	162.9	1.436	8.8	.059
Average		83.7	.727	8.2	.079	82.7	.723	8.0	.071
As_2O_3 in calyx:									
Inner cup, µg.			4.0				2.0		
Outer cup, µg.			22.0				19.3		
Total			26.0				21.3		
Percentage of apples injured by worms			35.2				34.9		

[3] The calcium caseinate consisted of approximately 75% of finely ground casein and 25% calcium hydrate.

[4] Triona is the trade name of an oil emulsion made of a fairly highly refined petroleum oil.

TABLE 1.—*Continued.*

BLOCK 5

1st calyx spray, omitted
2nd calyx spray, paste lead arsenate[5]
6 lb.–100 gal. and calcium caseinate 1 lb.–100 gal.
5 cover sprays, same as second calyx spray

BLOCK 6

1st calyx spray, lead arsenate 2 lb.–100 gal.
2nd calyx spray, lead arsenate 2 lb.–100 gal.
5 cover sprays, lead arsenate 2 lb.–100 gal.

Time of making analyses		Block 5				Block 6			
		Area per apple sq. cm.	As_2O_3 per apple mg.	As_2O_3 per sq. cm. $\mu g.$	As_2O_3 per pound grains	Area per apple sq. cm.	As_2O_3 per apple mg.	As_2O_3 per sq. cm. $\mu g.$	As_2O_3 per pound grains
Before 2nd cover spray	May 18	38.8	.088	2.3	.029	36.3	.065	1.8	.022
After 2nd cover spray	May 19	28.3	.176	6.2	.073	34.2	.141	3.9	.047
Before 3rd cover spray	June 3	47.8	.172	3.8	.040	47.8	.128	2.8	.030
After 3rd cover spray	June 5	45.4	.312	6.9	.075	45.4	.279	6.2	.064
Before 4th cover spray	July 7	88.2	.444	5.0	.043	85.0	.326	3.6	.034
After 4th cover spray	July 10	98.5	.912	9.2	.078	85.0	.690	8.5	.069
Before 5th cover spray	July 29	116.8	.988	8.2	.064	120.8	.840	6.9	.054
After 5th cover spray	July 30	136.8	1.890	13.9	.100	136.8	.984	7.2	.051
At harvest	Sept. 14	153.9	1.315	8.2	.058	141.0	.763	4.7	.032
Average		83.8	.700	7.8	.062	81.3	.457	5.1	.045
As_2O_3 in calyx:									
Inner cup, $\mu g.$			2.3				1.7		
Outer cup, $\mu g.$			6.6				12.0		
Total			8.9				13.7		
Percentage of apples injured by worms			27.3				31.4		

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[5] The paste lead arsenate contained approximately 50 per cent of water by weight.

Time of making analyses		BLOCK 7 1st calyx spray, lead arsenate 4 lb.–100 gal. 2nd calyx spray, lead arsenate 4 lb.–100 gal. 5 cover sprays, lead arsenate 4 lb.–100 gal.				BLOCK 8 1st calyx spray, lead arsenate 2 lb.–100 gal. 2nd calyx spray, lead arsenate 2½ lb.–100 gal. 5 cover sprays, lead arsenate 4 lb.–100 gal., and wheat flour[6] 2 lb.–100 gal.			
		Area per apple sq. cm.	As_2O_3 per apple mg.	As_2O_3 per sq. cm. µg.	As_2O_3 per pound grains	Area per apple sq. cm.	As_2O_3 per apple mg.	As_2O_3 per sq. cm. µg.	As_2O_3 per pound grains
Before 2nd cover spray	May 18	36.3	.102	2.9	.034	—	—	—	—
After 2nd cover spray	May 19	38.8	.279	7.2	.083	34.2	.169	4.9	.059
Before 3rd cover spray	June 3	45.4	.177	3.9	.040	47.8	.238	4.9	.054
After 3rd cover spray	June 5	47.8	.470	9.8	.101	45.4	.518	11.4	.133
Before 4th cover spray	July 7	85.0	.530	6.2	.053	85.0	.392	4.6	.040
After 4th cover spray	July 10	91.6	1.166	12.8	.112	91.6	.656	7.2	.061
Before 5th cover spray	July 29	116.8	1.238	10.6	.082	124.7	.636	5.1	.038
After 5th cover spray	July 30	136.8	1.226	9.0	.065	136.8	.842	6.2	.047
At harvest	Sept. 14	144.3	1.124	8.6	.057	162.9	.704	4.3	.027
Average		82.5	.714	7.9	.070	91.0	.462	5.4	.057
As_2O_3 in calyx:									
Inner cup, µg.				3.3			No calyx analyses made		
Outer cup, µg.				18.0					
Total				21.3					
Percentage of apples injured by worms				32.9			49.2		

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[6] The flour was added to determine its effect on the spreading of the spray and the amount of lead arsenate deposited on the fruit.

cation of the findings was also discussed at several meetings of importance, including that of the Pacific Division of the A.A.A.S. at Portland, Ore. in June, 1925, and the annual meeting of the A.A.A.S. at Kansas City in December, 1925 (30).

Nevertheless, it was recognized that there was need of securing from orchard experiments more exact and specific information concerning the above points than any such experiments had yet furnished; and studies with this purpose in mind were conducted during the years 1926 and 1927.

Orchard Experiments Made in 1926 and 1927

During 1926 an experiment was performed with the generous cooperation of Mr. Frank B. Herbert, Deciduous Fruit Entomologist of Balfour, Guthrie Co., in which two calyx sprays and five cover sprays were applied to each of eight different blocks of apple trees in a badly infested but well cared-for orchard near San Jose, California. Fifty apples were picked from each block immediately before and immediately after the second and third cover sprays, and, similarly, twenty-five were picked from each block before and after the fourth and fifth cover sprays and just before harvest. After the apples had been measured and weighed, the spray was dissolved off and analyses made for the purpose of ascertaining the average quantity of arsenic per square centimeter of apple surface and the average quantity of arsenic per pound of fruit, in relation to (*a*) the different spray materials, (*b*) the growth of the fruit in weight and surface area, (*c*) the weathering off of the spray and (*d*) the injury caused by the codling moth. Analyses also were made to determine the average quantity of arsenic in the calyx cups of the apples.

The more important results from this experiment are given in Table 1. A discussion of the methods and technique employed and the many factors pertaining to accuracy in the investigation must await a more extensive paper. It will suffice to note that the analyses prove that the fruit was heavily covered with lead arsenate throughout the season, although the percentage of apples injured by worms ranged from 27.3% to 49.2% among the different blocks.

Worm Injuries in Relation to Spray Deposits

A special study was conducted in the badly infested district at Yucaipa, California, for the purpose of determining whether larvae enter sprayed apples between the deposits of poison, at cracks in the deposits which may result from the growth of the fruit or at parts of the surface not reached in the application of the spray; or whether the entrances are made directly through the poison. In an orchard receiving five drenching cover sprays, worm-injured apples were picked before the third and fifth cover sprays and at harvest, and microscopic examinations made of such holes extending at least through the skin as had been made, as nearly as could be judged, by larvae between the time of the last preceding spray and the time of examination. The facts obtained in this study are summarized in Table 2. Approximately 20% and 90% of the entrances in the spotted coverage and film coverage, respectively, were effected by the larvae burrowing through the deposit of lead arsenate.

TABLE 2. SUMMARY OF THE RESULTS OF STUDIES MADE TO DETERMINE THE PLACES OF ENTRANCE OF LARVAE INTO SPRAYED APPLES IN RELATION TO SPRAY DEPOSITS

Time of making examination	Number of holes examined	Holes made on part of surface missed by spray	Holes made more or less distinctly between deposits of spray	Holes made definitely through deposits of spray	Place of holes too uncertain to classify
		per cent	*per cent*	*per cent*	*per cent*
		Coarse-spotted and overspray coverage			
Before 3rd cover spray	93	2.2	45.2	19.4	33.3
Before 5th cover spray	66	0	34.9	16.6	48.4
At harvest	112	0	48.2	35.7	16.1
		Spray applied with fish-oil-soap spreader; i. e., film coverage			
Before 3rd cover spray	16	18.7	0	75	6.3
Before 5th cover spray	10	0	0	100	0
At harvest	22	0	0	90.9	9.1

It was not possible to distinguish definitely between entrances and stings because many larvae in excavations just beneath the skin probably had swallowed poison and would have died had they not been destroyed when the apples were examined.

QUANTITY OF SPRAY APPLIED PER CUBIC YARD OF TREE VOLUME IN RELATION TO COMPLETENESS AND THICKNESS OF COVERAGE

The conclusion was reached that the most practicable measure of thoroughness in spraying trees is the quantity of spray applied per unit of tree volume with a given type of spray nozzle discharging spray at a given rate under a given pressure. An experiment was performed in which, at the time of the first cover spray, 6, 12 and 18 gallons of spray were applied to different trees, each tree measuring 42 feet over the top and 65 feet around, or approximately 16 feet high and 21 feet in diameter; the volume being 144 cubic yards;[8] i.e., approximately ⅓, ⅔ and 1 pint of spray per cubic yard of tree volume were applied in the different tests. The spray was applied from the outside of the trees (the trees were not sprayed from their centers) with a spray gun discharging three gallons per minute under a pressure at the gun of 300 pounds. Powdered acid lead arsenate was used at 8 lb. to 100 gal. of water.

Immediately after the spray had dried, 150 apples were picked and scored as to coverage, and after that they were measured and analyser made to ascertain the average amount of arsenic per square centimetes of surface. The data on the completeness of coverage shown in Table 3 and the data on the arsenic per square centimeter shown in Table 4, are derived from spray applied without spreader. The data indicate that drenching quantities of spray must be applied in order to obtain the maximum coverage and the greatest deposition of lead arsenate.

TABLE 3. EXTENT OF SPRAY COVERING ON APPLES, RESULTING FROM THE APPLICATION OF ⅓, ⅔ AND 1 PINT OF SPRAY PER CUBIC YARD OF TREE VOLUME[1]

	Percentage of apples with spray distributed over less than 50% of their surfaces	Percentage of apples with spray distributed over approximately 50% to 95% of their surfaces	Percentage of apples rated as having their surfaces completely covered
⅓ pint per cu. yd. (6 gal per tree)	76.6	23.3	0.0
⅔ pint per cu. yd. (12 gal. per tree)	32.0	50.6	17.3
1 pint per cu. yd. (18 gal. per tree)	21.2	32.0	46.0

[1] The fact should be emphasized that the so-called "invisible" or "barely visible" form of covering of lead arsenate was ignored in making the records for Table 3.

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[8] The formula $V = \frac{C^2}{4\pi}\left(\frac{O}{2} - 0.144\,C\right)$ was used in calculating the volume; this being the formula employed in the fumigation of citrus trees (37, p. 25). V = volume, C = circumference and O = the distance over the tree.

TABLE 4. QUANTITY OF ARSENIOUS OXIDE PER SQUARE CENTIMETER ON APPLES, RESULTING FROM THE APPLICATION OF ⅓, ⅔ AND 1 PINT OF SPRAY PER CUBIC YARD OF TREE VOLUME, USING POWDERED ACID LEAD ARSENATE AT 8 LB. TO 100 GAL. OF WATER[1]

	Micrograms of As_2O_3 per sq. cm.
⅓ pint per cu. yd. (6 gal per tree)	23.4
⅔ pint per cu. yd. (12 gal. per tree)	43.9
1 pint per cu. yd. (18 gal. per tree)	48.8

[1] The quantity of As_2O_3 per sq. cm. is higher than other studies (31) would indicate as correct for one application of spray at this concentration. This may have been caused in part by the fact that the calyx spray was applied late and some arsenic was deposited on apples by that spray.

ORCHARD EXPERIMENT ON THE PROTECTION AFFORDED BY FINE-SPOTTED AND COARSE-SPOTTED COVERAGES

A single tree 15 feet high and 21 feet in diameter was given one calyx and five cover sprays; the spray being applied with a spray gun discharging three gallons per minute under 300 pounds pressure at the gun and the sprayman standing sufficiently far away from the tree so that only the drifting, "fog" part of the spray reached the tree. Four and one-half gallons of spray was thus applied in each of the five applications. The surrounding trees each received 12 gallons of spray in each of five applications; i.e., they were decidedly oversprayed with the sprayman standing close enough so that the spray carried with force through the centers of the trees. Counts made at harvest showed that 89.4% of the apples were worm-injured on the tree having the fine-spotted coverage and 24% were injured on the heavily sprayed trees. It is recognized that the above experiment was very limited, but the spray was applied in such a manner and other influencing factors were such that the results are regarded as dependable.

ORCHARD EXPERIMEMT IN USING LEAD ARSENATE AT 1 LB. AND 4 LB. TO 100 GAL. OF WATER

At Yucaipa, California, twenty apple trees averaging 10 feet high and 16 feet in diameter were given three cover sprays, 7½ gallons of spray being applied to each tree at each application with a spray gun discharging 3 gallons per minute under 300 pounds pressure. Potash fish-oil soap was used as a spreader. Powdered acid lead arsenate was used at 1 lb. to 100 gal. of water on ten of the trees, and on the other ten trees the poison was used at 4 lb. to 100 gal. Examinations made August 20 revealed that 36% of the apples on the trees receiving the light concentration of spray had been entered by worms apparently unharmed while only 18% of the apples on the trees receiving the heavy concentration of spray had been thus entered by worms.

CONCLUSIONS

The investigation summarized in this paper tends to indicate that certain conceptions long held concerning spraying with arsenical compounds to control the codling moth are partially or wholly erroneous. It is somewhat puzzling to understand how such a situation could exist because we, as entomologists, have supposed that our recommendations and advice were adequately grounded on hundreds of experiments performed by scores of persons over a period of nearly fifty years. An analysis of the problem suggests that, in general, the methods and pro-

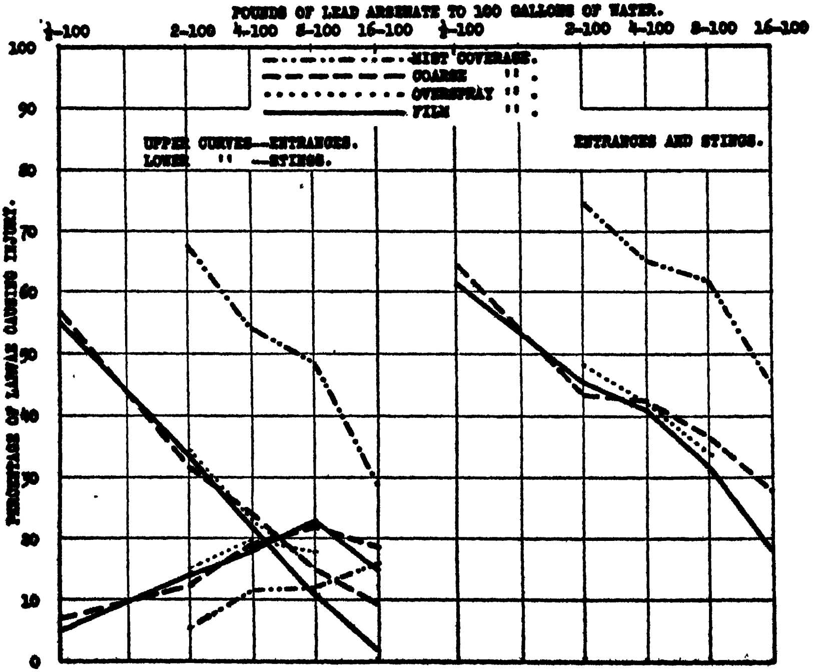

Fig. 38. Curves based on laboratory experiments involving the use of 374 apples and 9350 newly hatched codling moth larvae. The curves indicate the percentage of larvae producing injury to apples sprayed with powdered acid lead arsenate in amounts of ½, 2, 4, 8 and 16 lbs. to 100 gal. of water, with different types of spray coverages.

cedures followed in orchard spraying experiments have not been sufficiently exact to establish the true status of some of the factors dealt with in this paper. When confronted with data more or less contradictory and inconclusive, as frequently has been the case, authorities have preferred to adhere to the theory and presupposed facts. They have assumed that the "erratic" data were the result of experimental error but have failed to recognize that an equal measure of the "positive" data likewise should be regarded as the result of experimental error.

The investigation indicates that the degree of protection varies directly with the concentration of the spray and with the amount of lead arsenate on the fruit; that is, the thickness of the covering is an important factor in protectiveness. In this connection it may be noted that during the past year there has been a tendency to advise the use of three and four pounds of powdered lead arsenate to 100 gallons of water (9, p. 2, 3) (10, p. 161) (40, p. 60, 466) (11, p. 22) (8, p. 110, 111), which is quite contrary to evidence and advice previously available (2, p. 16) (3, p. 16) (12, p. 5, 18) (13, p. 18) (14, p. 18) (19, p. 14) (38, p. 41).[9]

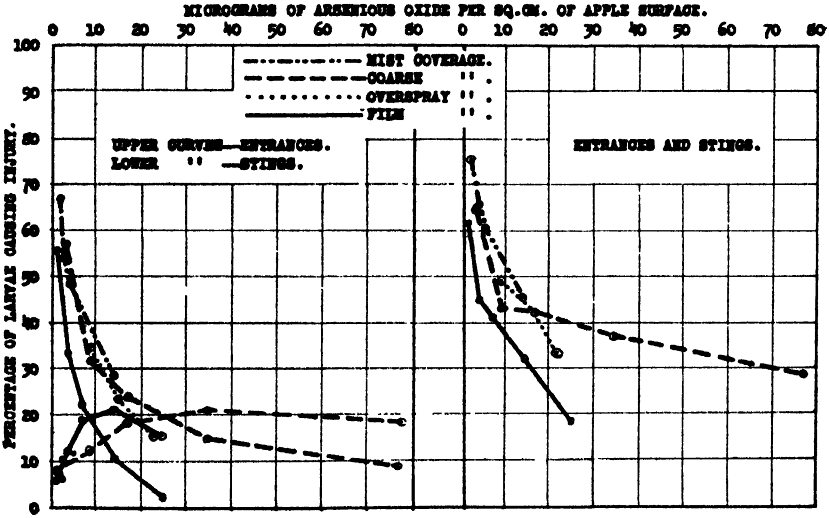

Fig. 39. Curves based on the experiments referred to in figure 2, indicating the percentage of larvae injuring apples in relation to the micrograms of arsenious oxide per square centimeter of apple surface, in the case of different types of spray coverages.

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[9] The latter references and also the following ones pertaining to the "mist" type of coverage, are by no means a complete list.

The fine spotted or "mist" type of coverage is shown to be decidedly less protective than the coarse spotted coverage, a fact quite opposed to the evidence and recommendations heretofore generally prevailing (1, p. 18, 27) (4, p. 65) (6, p. 44) (7, p. 79, 80, 81) (18, p. 323) (19, p. 18) (22, p. 9, 29, 35).

In order to even approximate the complete coverage of all the apples of a tree with coarse spots, or with a film in case a spreader is employed, and in order to place the maximum amount of the protective compound on the fruit, it is necessary to apply drenching quantities of spray to the tree. The completeness of coverage and the thickness of the coverage, within limits, vary directly with the quantity of spray applied per cubic yard of tree volume.

A large percentage of larvae are able to enter apples unharmed or produce marked injury to the fruit by burrowing directly through the film covering and deposits of lead arsenate. The idea generally expressed that complete coverage of the fruit with lead arsenate will result in the complete destruction of all the larvae attempting to enter the fruit is erroneous. Several persons have raised the question as to whether the codling moth larvae involved in this research may have developed a tolerance for arsenic. Although the question is one that deserves consideration, the writer believes that the apparently puzzling condition revealed by the investigation can be largely explained through the proper interpretation of experimental data available in the literature on the codling moth.

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A COMPARISON BETWEEN COMPLETE AND INCOMPLETE DIGESTION OF SPRAYED APPLE FOLIAGE IN DETERMINING ARSENIC BY THE GUTZEIT METHOD[1]

By JOSEPH M. GINSBURG, *Biochemist in Entomology, New Jersey Agricultural Experiment Station*

ABSTRACT

Quantitative analyses of arsenic by the Gutzeit method on sprayed apple leaves have shown that partial digestion of the dried plant tissue with dilute nitric or hydrochloric acid gives as accurate results as complete digestion with concentrated sulphuric and nitric acids. The incomplete digestion method consumes considerably less time and costs less than the complete digestion method.

INTRODUCTION

The Gutzeit Method is universally used in determining arsenic. It is very sensitive to arsenic and, if proper precautions are taken, such minute quantities as 1 part A_2O_3 to three millions of solution can be readily detected by it. This method depends primarily upon the evolution of arsine (AsH_3) from arsenic compounds (2) by nascent hydrogen liberated under the action of zinc. The evolved arsine reacts with $HgCl_2$

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[1] Paper of the Journal Series of the New Jersey Agricultural Experiment Stations, Department of Entomology.

or $HgBr_2$, forming a darkish-yellow compound, the color-intensity of which is directly proportional to the amount of arsine liberated, and of course, to the concentration of arsenic in the sample. For this purpose the arsenic must first be freed from the organic matter and brought into solution. The usual procedure is to digest the organic matter with concentrated sulfuric and nitric acids until all of it is dissolved. This process takes from three to six hours, depending on the kind of organic matter present in the sample to be analyzed, and is accompanied with offensive fumes from the nitric and sulfuric acids.

While studying the problem of "Stickers and Dilutents" it became necessary to determine arsenic on apple foliage sprayed with $PbHAsO_4$ mixture. During these analyses it occurred to the writer that the time consumed in completely digesting the plant tissue as outlined in the Official Methods of the Agricultural Chemists (1), could be considerably shortened if it should be possible to dissolve out all of the $PbHAsO_4$ from the plant material. Among the several reagents in which lead arsenate dissolves readily, dilute solutions of nitric and hydrochloric acids, and sodium hydroxide suggested themselves.

METHODS

Preliminary tests have shown that $PbHAsO_4$ dissolves very rapidly in dilute HNO_3 (5% to 10%) leaving a clear solution. This should be expected since the $Pb(NO_3)_2$ formed in the reaction is very soluble in water. The addition of NaOH to $PbHAsO_4$ resulted in a turbid mixture, due to the $Pb(OH)_2$ formed, which cleared up, however, upon heating. When HCl was used a heavy precipitation of $PbCl_2$ resulted which dissolved upon heating and reappeared upon cooling in form of long, needle shaped crystals. In order to determine whether or not all of the As_2O_3 can be recovered from $PbHAsO_4$ when treated with the above reagents the following experiment was carried out. Several 0.2 gm. samples of $PbHAsO_4$ alone and mixed with 1 gm. of unsprayed apple foliage were transferred to 250 c.c. beakers. The samples were then treated with 25 c.c. of one of the following solutions, 10% HNO_3, 10% HCl, 20% HCl, 10% NaOH. In a similar way 1 gm. samples of sprayed apple foliage were prepared. The mixtures were boiled for about 30 minutes under the hood with frequent stirring until the sample containing organic matter became a thick pulp and most of the HNO_3 and HCl was eliminated. The pulpy mass was then diluted, filtered and washed several times with hot distilled water. The volume of the filtrate was made up to 100 c.c. and 1 c.c. aliquots were taken for arsenic analyses. The modified Gutzeit Method as outlined in Scott (2) was used. Alongside with the above determinations two samples of sprayed apple foliage were completely digested with concentrated nitric and sulfuric acids and were analyzed for As_2O_3.

It may be well to mention here that all the chemicals (except the NaOH which consisted of the usual C. P. sticks, obtained from Eimer & Amend) used were arsenic "free". Precautions were also taken to add the same quantities of reagents to each sample and to select uniform strips of $HgBr_2$ paper. The last item is very important because the length and intensity of the color stain will be influenced by the texture and width of the strips.

EXPERIMENTAL

The results presented in Table 1 show that all of the As_2O_3 can be recovered from $PbHAsO_4$ when used either alone or when mixed with leaf tissue by partial digestion with either 10% HNO_3 or with 20% HCl. Furthermore, the amount of As_2O_3 found on sprayed foliage when digested with either one of the above two reagents was practically the same as that recovered by the complete digestion method. The results obtained with 10% HCl were not as constant as those obtained with the 20% HCl. When the organic matter containing $PbHAsO_4$ was treated with 10% NaOH the quantities of As_2O_3 determined were considerably higher than those obtained by complete digestion.

TABLE 1. As_2O_3 RECOVERED FROM $PbHAsO_4$ AND FROM DRIED, GROUND APPLE LEAVES MIXED OR SPRAYED WITH $PbHAsO_4$, RESULTS IN MGM.

Sample No.	Composition of sample	As_2O_3 mgm. added	Reagents 10% HNO_3	 10% HCl	 20% HCl	 10% NaOH	 Complete Digestion[1]
1	0.2 gm. $PbHAsO_4$	56 mgm.	58	52	55	54	——
2	1 gm. unsprayed apple leaves 0.2 gm. $PbHAsO_4$	56 mgm.	54	50	54	65	——
3	1 gm. sprayed apple leaves	———	0.375	0.350	0.368	0.85	0.375
4	1 gm. sprayed apple leaves	———	1.25	1.20	1.30	1.85	1.25
5	1 gm. sprayed apple leaves	———	1.20	1.00	1.20	1.60	1.10
6	Blank 1 gm. unsprayed apple leaves	trace	trace	trace	trace	.0005 to .001	trace

[1] Official methods

In order to obtain some further data on the accuracy of the incomplete digestion method, ten different batches of apple leaves, which had been sprayed with sulfur lime dry mix containing 1.5 lbs. of $PbHAsO_4$ per 50 gallons of spray, were selected for testing. Two sets of analyses were run. Duplicate 1 gm. samples of the dried, pulverized apple leaves were completely digested in the first set with concentrated nitric and sulfuric acids and incompletely digested in the second set with 10% nitric acid. Averages of the duplicate analyses are presented in Table 2.

TABLE 2. AMOUNTS OF As_2O_3 RECOVERED FROM 1 GM. OF SPRAYED APPLE LEAVES BY BOTH COMPLETE AND INCOMPLETE DIGESTION METHODS

Sample No.	Complete Digestion As_2O_3 mgm.			Incomplete Digestion As_2O_3 mgm.		
	1	2	Average	1	2	Average
7	1.20	1.25	1.25	1.25	1.15	1.20
8	1.10	1.10	1.10	1.20	1.15	1.17
9	1.25	—	1.25	1.20	1.20	1.20
10	1.15	1.05	1.10	1.15	1.25	1.20
11	0.45	0.45	0.45	0.45	0.45	0.45
12	0.35	0.35	0.35	0.45	0.35	0.40
13	0.75	0.75	0.75	0.75	0.75	0.75
14	0.55	0.55	0.55	0.55	0.55	0.55
15	0.35	0.35	0.35	0.25	0.25	0.25
16	1.05	0.95	1.00	1.05	0.85	0.95

A comparison of the results secured from the two sets of analyses do not reveal any appreciable differences between the amounts of arsenic recovered from the apple leaves by the two methods. The variations observed are not in any way greater than those usually encountered between duplicate analyses of the same sample and can be included within the limits of experimental error.

It appears, therefore, from the data obtained in the above experiments that arsenic present on sprayed apple foliage can be completely recovered by subjecting the finely ground plant material to partial digestion with either 10% HNO_3 or 20% HCl. Digesting the apple leaves with dilute acids presents several advantages over the complete digestion.

(1) It reduces the time consumed in the complete digestion to about one hour.

(2) It eliminates the offensive fumes from the concentrated sulfuric and nitric acids.

(3) It costs less.

SUMMARY

Two methods of digesting sprayed apple foliage for arsenic analysis were tested out. In the first method the finely pulverized plant tissue was subjected to complete digestion with concentrated HNO_3 and H_2SO_4 until all the organic matter was in solution. In the second method the plant material was boiled with either 10% HNO_3 or with 20% HCl for about thirty minutes, filtered and washed. Chemical analyses have shown that the amounts of As_2O_3 recovered from the thus partially digested plant material were practically the same as those recovered from the completely digested plant material.

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AN EXPERIMENT IN TRAPPING CUTWORMS

By W. D. WHITCOMB, *Massachusetts Agricultural Experiment Station, Market Garden Field Station, Waltham, Mass.*

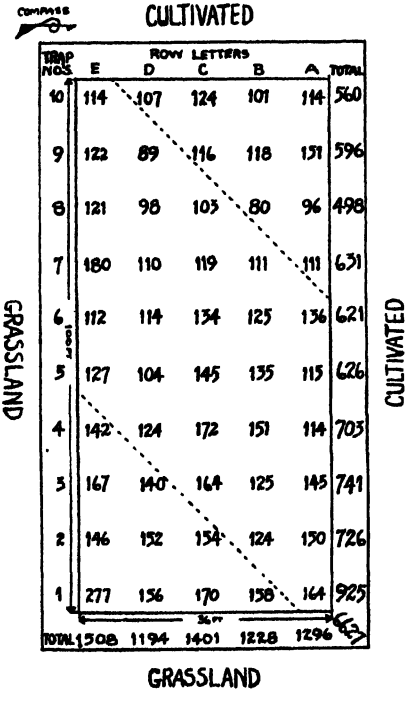
ABSTRACT

7703 cutworms were collected in traps at Waltham between April 27 and July 17, 1927. Chickweed sods were used as traps in the largest experiment where 6627 cutworms were collected but shallow trays with a screen bottom when baited with chickweed proved to be as effective and were more easily handled. The cutworms in Group 3 which included *Euxoa ochrogaster*, *Euxoa tessellata*, and *Euxoa perpolita* comprised 94.34% of the larvae collected. *Agrotis fennica* and *Agrotis unicolor* were trapped in noticeable numbers. Rain and general cold cloudy weather noticeably decreased the numbers of cutworms collected while temperature variations had a less noticeable influence.

While collecting garden cutworms in traps for insectary studies at Waltham in the spring of 1927, it was apparent that, if the collections were made at regular intervals, the records would indicate the periods of seasonal abundance of the cutworms and to a lesser degree their migratory habits and their reaction to climatic changes. Three trapping experiments in which the traps were examined at 2 and 3 day intervals resulted in the collection of 7703 cutworms.

The majority of the cutworms were collected in a field 100 feet long and 36 feet wide in which sod had been plowed under, August 4, 1926. As shown in Fig. 41 the field was surrounded on the east and south by grassland and on the north and west by cultivated land. On April 25, 1927 it was harrowed and fifty sods of chickweed (about 8 inches in diameter) were placed in 5 rows running lengthwise in the field. The rows were 6 feet apart and the sods 9 feet apart in the rows. Chickweed was selected as bait because it was readily available and could be handled easily although it seems reasonable that fresh greens such as clover, lettuce or spinach would be equally satisfactory.

The cutworms were collected by shaking them from the sod and by picking them from the soil under and adjacent to the sod. During the prevailing wet weather of May and June 1927 the chickweed sod remained fresh for 10 to 14 days in spite of up-rooting at each examination but during periods of hot dry weather it was necessary to renew the sods in 3 or 4 days. A few times some of the sods were scratched and scattered over the field by pheasants, a male bird being observed doing this once, and numerous skunk tracks indicated that these animals were interested undoubtedly from a gastronomical standpoint, but for the most part the traps were unmolested.



TRAP NOS.	E	D	C	B	A	TOTAL
10	114	107	124	101	114	560
9	122	89	116	118	151	596
8	121	98	103	80	96	498
7	180	110	119	111	111	631
6	112	114	134	125	136	621
5	127	104	145	135	115	626
4	142	124	172	151	114	703
3	167	140	164	125	145	741
2	146	152	154	124	150	726
1	277	156	170	158	164	925
TOTAL	1508	1194	1401	1228	1296	6627

FIG. 40.—Diagram showing the number of cutworms collected in traps, 1927.

In Fig. 40 is shown the number of cutworms collected in each of the 50 chickweed traps. The largest number 277 was taken from Trap E-1 in the southeast corner and the smallest number 80 from Trap B-8. Collections were made in this field from April 27 to July 1 and the total number collected was 6627 for an average of 132.54 cutworms per trap.

Although the summer-plowed land provided ideal conditions for oviposition by certain species of cutworm moths, it is unreasonable that 6627 cutworms were located in 3600 square feet of cultivated land and could be collected in varying numbers over a period of nine weeks. Therefore, it is apparent that many of them were attracted to the cultivated land and migrated from adjoining areas in search of more desirable food. This assumption is strengthened by reference to Fig. 40 which shows that the greatest number of cutworms per row were taken from long Row E and short Row 1 both of which bordered on the grassland from which the cutworms would be expected to migrate. Also that the number of cutworms from the 10 traps nearest the E-1 corner indicated in Fig. 40 by a dotted line, exceeded the average by 332 and that those from 9 of the 10 traps nearest the A-10 corner, also indicated by a dotted line, numbered 230 less than the average, the exception being trap A-9 with 151.

When the success of chickweed sods as cutworm traps became apparent, a screen trap was devised which facilitated the examination of the traps and increased the probable accuracy of the records. This trap was 15 inches square and made from 1¼ inch lattice with a 14-mesh copper wire screen bottom. When set in the field, the top was even with the surface of the soil. Two or three handfuls of earth were thrown in the bottom and corners and a chickweed sod placed in the center. When examining these traps the chickweed was quickly shaken and the loose soil sifted through the screen bottom, leaving the cutworms and larger particles of dirt in the trap.

In order to compare the screen traps with the chickweed sods, five traps of each type were run side by side from May 5 to May 17, being examined 5 times. From the screen traps 72 cutworms were collected and 64 from the chickweed sods.

On May 18, the screen traps were moved to an asparagus field which was quite weedy. The weeds were cleared from 3 rows (about 16 feet) and 10 traps placed in the center row about 15 feet apart. These traps were examined 20 times at 3-day intervals between May 20 and July 17 and 940 cutworms were collected from them. This gives an average of 94 cutworms per trap as compared to an average of 98.7 from the chickweed sods in the larger field during the same period. In both of these collections the screen traps were practically as effective as the chickweed sods for collecting cutworms.

At the time of collection in the field the cutworms were separated into four groups from which the species were determined later by a study of of the reared moths.

Group 1 included those cutworms which became full grown early in the spring and whose external appearance is distinguished by a brown ground color with prominent wedge-shaped black markings along the back and sides. This brief general description applied to both *Agrotis unicolor* Walk., the W-marked cutworm and *Agrotis c-nigrum* L., the Spotted Cutworm, but of the 65 individuals which were reared to the adult stage only one proved to be *A. c-nigrum*. The cutworms in Group 1 represented 0.86% of the total number collected in the traps and were active while the night temperatures were still close to freezing while the majority of them pupated early in May.

Group 2 which represented 1.62% of the total included but one species, *Agrotis fennica* Tausch., the Black Army Cutworm. This species was most numerous from May 1 to May 10 but continued to be present in small numbers until early June. It was the most injurious cutworm to asparagus even when present in smaller numbers than the species in Group 3.

In Group 3 which contained the largest number of individuals and represented 94.34% of the total number were placed the common type of garden cutworm in this section. Their external appearance is characterized in general by a light gray ground color with darker rather indistinct transverse lines on the back, having many brown freckles on the head and prominent black spiracles. Larvae ranging from recently-hatched (about ¼ inch long) to nearly full-grown (about 1¼ inch long) were found in the traps throughout the collections. Some of the larvae of this group were reared to the imago and it was then found that three species were included. These have been determined as *Euxoa ochrogaster* Guen., the Red Backed Cutworm; *Euxoa tessellata* Harr., the Common Striped Cutworm; and *Euxoa perpolita* Morr. The larvae in this group were active through May and June reaching their greatest abundance, 1021 individuals, on May 30 when many of the garden vegetables are most susceptible to their attack.

In Group 4 are placed those species which were not recognized and those which were present in very small numbers. It is possible that some of those included in this group were the same species as listed in Groups 1, 2, and 3, especially Group 3, but if so they were not sufficiently numerous to influence the records. In addition to those named above, the following species were reared from larvae collected in the traps:

Feltia subgothica Haw.—Dingy Cutworm
Noctua smithii Snell.—
Polia (*Mamestra*) *renigera* Steph.—Bristly Cutworm
Sidemia (*Hadena*) *devastator* Brace—Glassy Cutworm
Noctua bicarnea Guen.—
Lycophotia margaritosa var. *saucia* Hub.—Variegated Cutworm

The moths were determined by comparison with those in the collection at the Boston Museum of Natural History and with the assistance of Dr. C. W. Johnson, curator at this Museum.

The seasonal abundance of each group as indicated by the collections in the larger trap experiment is shown diagrammatically in Fig 41.

During these studies it was apparent that cutworms were more active when the soil was dry and the night temperature moderately high. The season of 1927 with its frequent rains offered an excellent chance to test this point.

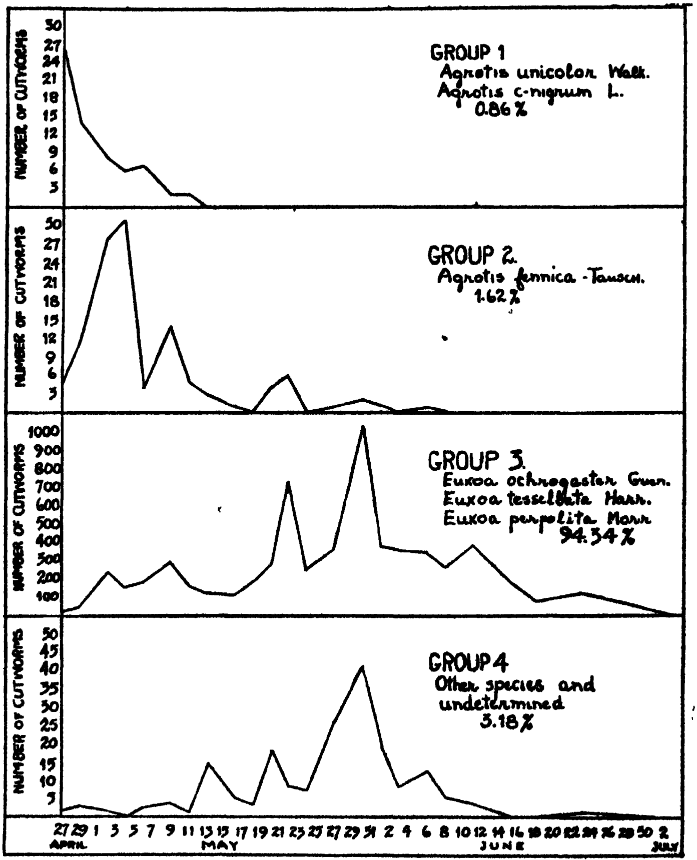


FIG. 41.—Period of activity and relative abundance of cutworm groups collected in traps at Waltham, Mass., 1927.

In Fig. 42 the collection record of the larvae in Group 3 is shown graphically together with the daily precipitation in tenths of an inch as recorded at the U. S. Weather Bureau station at Boston (10 miles east), and the average temperature between 6.00 P. M. and 6.00 A. M. as calculated from thermographic records obtained at Waltham. Between April 27 and July 1, 5.46 inches of rain fell and there were only 21 clear days. A study of Fig. 42 shows that at least 2 days of dry weather preceded the greatest increase in the number of larvae, e. g., May 9, 22, 30 and June 11 and that following a rainfall of two-tenths of an inch or more, the number of cutworms collected decreased or remained about equal to the previous collection. It appears, therefore, that cutworm migration and activity is retarded by wet weather. The temperature graph shows rising temperatures preceding the largest collections, but

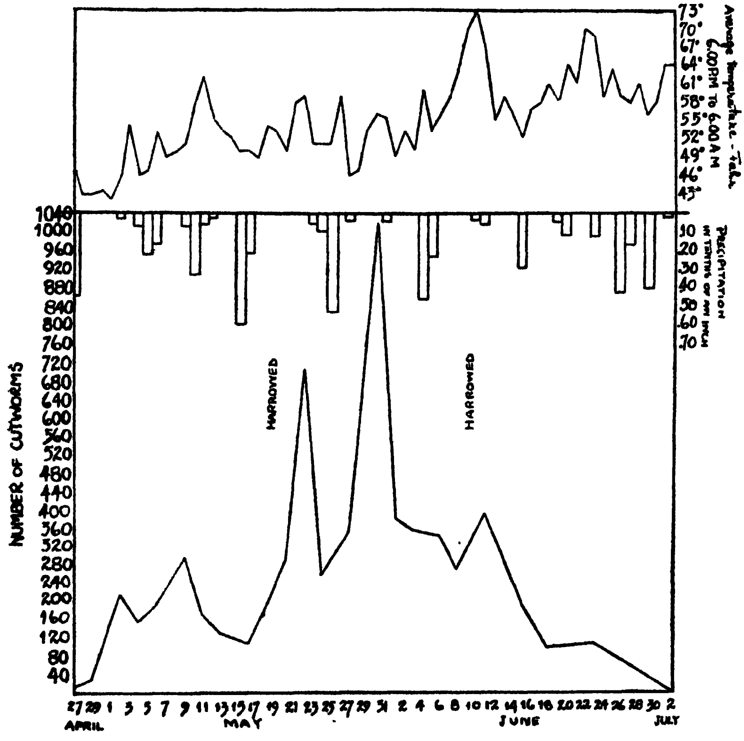


FIG. 42.—Diagram showing the relation of precipitation and temperature to the numbers of cutworms of group 3 collected in traps at Waltham, Mass. 1927.

other rising temperatures failed to increase the collections greatly and it is evident that temperature fluctuations have little influence in this respect except as they tend to reflect the precipitation record.

In order to keep down weeds, the field was harrowed on May 18 and June 9. This reduced the food supply of the cutworms and the number which were attracted to the chickweed baits following the cultivation increased in each instance.

Although cutworms are primarily negatively phototropic, larvae were frequently found on bright days lying unprotected in the loose soil apparently taking a sun bath.

The results of these studies indicate that cutworm traps may be used advantageously by entomologists to secure larvae for study or exhibition; to determine the time and degree of seasonal abundance of different species of cutworms in various localities; and to determine when to recommend the application of control measures. Gardeners will find them useful to determine if cutworms are sufficiently abundant before crops are susceptible to attack to warrant applications of control measures, and to reduce infestations by trapping cutworms along the outer borders of a garden.

STUDIES IN BREEDING INSECTS THROUGHOUT THE YEAR FOR INSECTICIDE TESTS

I. House Flies (*Musca domestica*)

By A. G. Grady, *Entomologist, Research Laboratories, The Rohm and Haas Co., Inc., Bristol, Pa.*

Abstract

A method for year around rearing of the large numbers of flies (*M. domestica*) required for insecticide tests has been developed. The equipment consists of an inexpensive insectary, breeding cages, rearing jars and stock cages. The technique of breeding, rearing, feeding and handling large numbers of larvae and adults has been made very simple and convenient. As a result of the procedure described, large cultures of flies of high vitality can be developed as easily in winter as in summer. Flies reared as described reach maturity sooner and have a shorter adult life span.

Introduction

An extensive study upon the effect of insecticidal compounds on house flies was interrupted during the winter of 1926–1927 when the progeny died in the larval and pupal stages about the first week in January. Accordingly, attention was turned to a search for a method by which flies could be reared in large numbers readily and dependably throughout the winter season. This paper details the results of a successful method evolved whereby large numbers of flies can be reared through the whole year. As the technic employed is very simple, inexpensive and dependable it may prove of value to entomologists who require large numbers of house flies for biological experiments throughout the year. Full credit for the continuous breeding of this insect-should be given to Glaser[1] who conceived the idea of supplementing the larval medium with yeast cells suspended in water during the winter months.

The literature on the biology of *Musca domestica* has assumed extensive proportions and it is not the intention of the writer to deal with it except to note some observations on the activity and longevity of the imagines during the winter months.

The larvae were reared throughout the winter on a medium consisting of fresh horse manure which was kept in a moist condition with water and yeast cells suspended in water, according to Glaser's method. Excellent results were obtained. -Attempts were made during the latter half of January and during the month of February to rear flies on horse manure alone. In every case, except two, the insects died either in the larval or pupal stages. In the two successful attempts the horse manure was taken from the stables during a warm spell. Whether this had anything to do with carrying the larvae through to the adult stage was not determined.

From these experiences and the experiences of other investigators it was concluded that unless the horse manure was supplemented during the winter months larval life could not be supported and a continuous supply of insects could not be maintained.

The adult insects thrived exceedingly well on a diet consisting of milk, lump sugar, sweetened bread and yeast suspended in water. About 10 cc. of milk was dropped into the cages every day and about the same amount of yeast suspension was fed every second day. Fresh sweetened bread was placed in the cages about once a week. The bread was kept in an assimilable condition by wetting it with water. Other foods were added to this diet at different times such as beef extract, casein and fish-scrap. However, the adults developed sufficiently well on milk, bread, sugar and yeast so that the strictly protein foods were not used as regular parts of the diet.

The apparatus and equipment used to rear the house flies throughout the winter months were as follows: An insectary where the breeding cages, rearing jars and stock cages were kept; breeding cages in which the insects were bred and oviposition took place; rearing jars in which the insect was reared from the egg to the adult stage; and finally, stock cages where the flies used for insecticidal tests were kept.

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[1] Note on the continuous Breeding of Musca domestica. Journ. Econ. Ent., 1927, XX, 432–433.

INSECTARY

A chamber 8½ feet long, 4 feet wide and 8 feet high was built in a laboratory attic. A window was provided at one end which admitted sufficient light to carry on the work. Entrance was obtained by a small door at the opposite end of the chamber. All cracks where the woodwork joined the floor and ceiling and around the door and window were covered with weather stripping to prevent drafts. Shelves, 1 foot wide, were built along the sides of the chamber to hold cages and rearing jars. The heating element which consisted of a well trapped steam coil was placed underneath the window. A fairly constant temperature was maintained with a Sarco heat regulator. This regulator was set at 30° C., (86° F.). Any variations of temperature were recorded on a maximum and minimum thermometer which was placed next to the thermostat. In this manner the temperature stayed within two or there degrees. A simple humidifier consisting of a trough 35 inches long, 12 inches wide and 6 inches deep, filled with sawdust was placed under the steam coil The sawdust was wetted down at intervals to keep the relative humidity at about 40%. A wet and dry bulb thermometer was used to check the humidity of the chamber.

BREEDING CAGES

Because flies are susceptible to nutritional deficiency diseases and to attacks of parasites and parasitic fungi it was found best to keep the insects used for breeding purposes in relatively small separate cages so that if one colony of breeders became infected the disease could be checked before it spread to the other cages. As a result of this precaution, no high mortality occurred among the flies in the breeding cages that could be laid to a diseased condition.

As it was desired to have on hand hundreds of flies of known ages at all times, six breeding cages were used. Their dimensions were: length, 18 inches; breadth, 9 inches; height, 10 inches. The floor was made of a board ½ inch thick to which the frame was attached. The frame was constructed of ½ inch strips. The upright strips were nailed to the floor of the cage and connected by ½ inch crosspieces. The sides, top and back were made of wire fly screening, (1/16 inch mesh) tacked to the frame. The front was a piece of glass set in grooves which served as a door. These cages are easy to clean, provide plenty of room for the insects to move about and access to the inside is gained easily by pushing up the glass door to introduce food and insects.

REARING JARS

Ordinary battery jars 6 inches in diameter by 8 inches high were used for rearing the larvae. The top of the rearing jar consisted of a piece of cheese cloth about 8 inches in diameter with a hole about ¾ inches in diameter in the center. This hole was reinforced by heavy paper washers about 1½ inches in diameter glued to both sides of the cheese cloth. A cork plug was inserted in the exit hole. The top was held in place by a ¾ inch elastic band. This type of top is inexpensive, easily made and will serve for a number of generations of flies.

STOCK CAGES

As flies were not used for insecticidal tests after they were five days old only five cages were necessary. These cages were boxes of ½ inch lumber, 24 inches long, 12 inches broad and 10 inches high. One side was fitted with a hinged wooden door 3 inches by 3 inches to admit flies and introduce food. The top of the cage was made of wire screening (1/16 inch mesh). In the center of the wire top a hole about ½ inch in diameter, for the removal of flies, was made and a cork inserted.

PROCEDURE

In each of the six breeding cages about two hundred adult flies, about equally divided as to sex, were kept. When the insects died or became unduly soiled or injured they were replaced by others. A 200 cc. beaker filled with wet horse manure was placed in each cage for the flies to oviposit on. In the course of two days hundreds of eggs were deposited on the medium, about half of which had hatched. Every other day the beakers containing eggs and larvae were removed. Other beakers filled with fresh horse manure, to which about 15 cc. of water had been added, were then placed in the breeding cages. In this way fresh medium was kept in the breeding cages continually for the flies to oviposit on. It appears that this part of the technic stimulated the responses of the females in regard to oviposition and aided somewhat in keeping the flies from laying eggs on the adult food, i.e., the sweetened bread.

To insure a large supply of adults, four cultures were started every other day. About five or six hundred eggs and larvae, obtained as above, were transferred to each of the four rearing jars. Each jar was filled to about the three-fourths mark with fresh, loosely packed horse manure. It was found that if about 200 cc. of water was added to the manure when the culture was started it was sufficient to keep the medium in a moist condition until the adults emerged. The losses resulting from larvae drowning were insignificant. To this 75 cc. of the supplementary food, yeast cells suspended in water, was added and about 10 cc. more was dropped in the jars every other day until the larvae were about ready to pupate. The amount of yeast to be fed varies, of course, with the number of larvae to be reared. It was found that in this case if the amount of yeast suspension was cut down the adults, if they emerged, were apt to be stunted and possess little vitality. In making up the yeast suspension Glaser[1] advises, "In practice we dissolve a one pound bakery cake of commercial yeast in two liters of water. The suspension of yeast cells is then distributed in pint bottles and autoclaved, to kill fungi which often cause trouble, and stored on ice." We have found that if one pound of yeast is dissolved in two and one half or three liters of water, very good results can be obtained. At first the yeast suspension was autoclaved using pint milk bottles as receptacles. A pyrex flask was later substituted for the milk bottles as these are apt to crack when subjected to high temperatures a few times. A number of cultures were reared using yeast suspension which was not autoclaved. While this part of the technic may be left out, with little or no difference in the results, it is advisable to sterilize the yeast suspension if an autoclave is available. The horse manure containing eggs and larvae was then emptied onto the fresh medium, the covers fitted on the jars and the culture was incubated at 30° C. The larval medium settled in a few days to about the middle of the jar which gave the adults plenty of room to move about when they emerged.

At this temperature the time required from egg to adult was approximately eleven days. As the eggs were deposited over a period of two days in the breeding cages some of the adults emerged nine days after being placed in the rearing jars and the rest within eleven days, other conditions remaining equal. As the flies emerged they were taken out of the jar in the following manner: The cork plug was removed from the top of the rearing jar and a wide mouthed bottle placed over the exit hole. The jar was then darkened, except around the exit hole, with a cloth cover. As house flies are positively phototropic, most of them will come out into the bottle in a few minutes. The flies were then either placed in a stock cage to be held for insecticidal tests or used for breeding purposes. It is advisable to take the flies out of the rearing jars soon after they emerge so as to avoid overcrowding. When large numbers of adults are allowed to stay in the rearing jars they are apt to become excited and mill about the top of the jars in an effort to escape. This often results in a high mortality.

To draw any conclusions from insecticidal tests which would shed light on the toxicity of a compound the age and the condition of the insects used should be known. This appears to be particularly true of flies. We have found that the adult house fly bred under artificial conditions during the winter months is most active and resistant when it is four or five days old. In comparing results of insecticidal tests run during the summer with wild flies and those reared artificially it developed that winter flies, four or five days old, were more uniformly resistant to toxic compounds than wild summer flies and fully as resistant as controlled cultures developed during the summer. As the age of the flies was of great importance they were kept in separate cages dependent on the date they emerged.

After the fifth day flies which had not been used for insecticidal tests or transferred to the breeding cages were killed. The cage was then thoroughly washed with soap and water and dried. As the adults were continually emerging in the rearing jars it was necessary to use the cage immediately for a new supply. In this way a continuous cycle was maintained with a minimum number of cages.

When flies were needed for insecticidal tests they were removed by the bottle method described above. The approximate number desired were collected in a few moments. As a matter of precaution it is advisable to darken the cage gradually as the flies are easily excited and may injure themselves mechanically if suddenly aroused.

Observations

A few observations on the activity and longevity of the adults during the winter months were made. It was found that the adult fly was very active and resistant until about the eighth day after it emerged, reaching what might be called its peak of activity and resistance about the fifth day. The longevity of the adult varied from two to thirty-three days with an arithmetical mean of thirteen plus days. It was also noted that the ovaries and testes developed rapidly and in some cases eggs were deposited by the flies in a little over three days after the time of emergence. Some investigators[2] have reported that the life of the adult house fly, reared during the warmer seasons, averages approximately twenty days and that the time required for the development of the ovaries and testes was longer by several days than observed in this case. Whether this comparatively short life cycle and rapid development was due to the fact that the flies were continually subjected to a constant temperature of 30° C., a special diet, absence of direct sunlight, or to other factors was not determined.

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[2] Howard, House Flies, U. S. Dept. Agri. Farmers Bulletin, 679, 1915; Glaser, Rearing Flies for Exp. Purposes with Biological Notes, J. Econ. Ent., 1924, XVII, 486–496.

During the spring, summer and early fall the flies were reared in a part of a greenhouse which had been partitioned off. The same technic was employed as described in the preceding pages except that the supplementary food was not fed to the larvae. The cultures were transferred to the winter insectary toward the latter part of October. Of course, the time of transfer will depend on climatic conditions.

The writer takes this opportunity to express his indebtedness to Dr. W. S. Abbott of the Bureau of Entomology and to Dr. R. W. Glaser of the Rockefeller Institute for Medical Research for the valuable suggestions embodied in his papers and for his personal assistance.

SUMMARY

A convenient insectary and cages and simple methods are described for breeding large numbers of house flies during the winter. A few observations on the activity and longevity of the adults are noted.

STUDIES IN BREEDING INSECTS THROUGHOUT THE YEAR FOR INSECTICIDE TESTS

II. Leather Beetles (*Dermestes vulpinus* Fab.)

By A. G. Grady, *Entomologist, Research Laboratories, Rohm & Haas Co., Inc., Bristol, Penna.*

ABSTRACT

The leather beetle (*D. vulpinus* Fab.) has been used with very good results for certain kinds of insecticidal experiments. This insect can be reared simply and dependably in large numbers throughout the year. Compared to some insects it is very resistant to certain toxic compounds and serves very well in measuring their insecticidal efficiency.

INTRODUCTION

The value of having on hand an adequate supply of suitable insects for insecticidal experiments throughout the year instead of during their natural occurrence is, of course, fully realized. It is not only desirable to obtain and rear, throughout the year, insects that are prolific, can be easily handled and have comparatively short life cycles, but it is also of importance that these particular animals should be as resistant, or more so, to toxic compounds as insects found in the household and those of economic importance to agriculture.

A search was made for an insect that would meet the above requirements and after considerable investigation it was decided that the leather beetle (*Dermestes vulpinus* Fab.) would serve very well as a standard insect for biological experiments.

This paper gives a short description of the biology of *D. vulpinus*, the technic employed in rearing large numbers throughout the year and its value as an experimental insect for biological tests.

Biology

As *Dermestes vulpinus* is of comparatively little economic importance very little reference is made to its biology in the literature. Riley in one of his reports[1] gives an account of this insect as a destroyer of leather goods and Illingworth[2] has made a complete study of its biology and has written on its destructive habits as a pest to the fishing industry in Hawaii. It was necessary, of course, to make a complete study of this insect if it was to be used as a standard insect for insecticidal tests. The following notes on the biology of *Dermestes vulpinus* were made during the winter at a temperature of about 23° C. and the relative humidity at about 40%. A short description is also given.

The time required from egg to adult at the above temperature was about fifty-five days. The eggs, which are about 2 mm. in length, of a creamy-white color and cylindrical in shape, hatch in three or four days. The larvae upon hatching are about 2 mm. long, attaining a length of about 12 mm. before pupating. The dorsal surface is covered with a complex clothing of hairs and is of a dirty brown color. The larvae are very active and are voracious eaters. The number of times the larvae moult varies but in the course of their development, the average is seven. We have observed some larvae shed their skins ten or eleven times during their development, presumably because of a scarcity of suitable food. In all about forty-four days are spent in the larval stage. When the larvae are about to pupate the larval skin splits down the back and remains as a pupal covering. On the last larval skin a number of spines occur serving as a protection for the pupa. The larvae are negatively phototropic and are generally found in dark places. Illingworth[2] observed that the larvae are fully developed after the sixth moult and that the complete larval period for the seven instars was found to require fifty days, while the life cycle, from egg to adult, was passed in sixty-four days, which is somewhat longer than we have observed.

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[1] Riley, C. V. "The Leather Beetle or Toothed Dermestes." Rept. Comm. Agric. U. S. 258-264, 1885.

[2] Illingworth, J. F. "The Leather Beetle (*Dermestes vulpinus* Fab.), a Troublesome pest of Dried Fish in Hawaii." Proc. Haw. Ent. Soc. III, No. 5, April, 1918.

The pupal stage lasts seven or eight days. After the imago emerges it passes through a preoviposition period of about ten days. The adult beetle is from 8 to 12 mm. in length and rather slender, the male being smaller than the female. The antennae are short, terminating in a large club and on the underside of the thorax is the characteristic hollow for their reception. The elytra and dorsal surfaces of the pro-thorax and head are black specked with gray. The margins of the thorax are covered with grayish scales. The ventral surface is of a silvery-white color with a series of lateral spots which appear to be bluish-black because of the absence of scales. The adult is a weak flier seldom making use of its wings and then only for short flights. It is very quick on its feet and will run rapidly to cover if disturbed. However, it is much easier to handle in this respect than a cockroach. The adult beetle has a life span of four or five months or more and reproduces over a period of two months at least. According to Illingworth[2] "Beetles that emerged Jan. 2, 1917 are still alive and actively reproducing April 5th, 1917."

REARING TECHNIC EMPLOYED

The methods employed in rearing large numbers of these insects are very simple and quite inexpensive. After a culture has been started little or no attention need be paid to it, except for the addition of food, until the adults emerge.

At first the insects were reared in a large wire cage. This cage was 6 feet by 6 feet by 6 feet with a frame of 2 by 2 inch lumber to which ordinary fly screening was tacked. This cage served very well during the winter and thousands of insects were reared in it. However, about the middle of the following summer the larvae were attacked by parasites and the whole culture was killed in a very short time. Tin cans were then substituted for the above cage and the culture reared in separate units. These containers were 10 inches in diameter by 8 inches high and were equipped with tight fitting covers. Holes were punched in the centers of the covers to admit air and keep down the humidity. Very good results were obtained with this type of rearing container. By rearing the insects in separate chambers little trouble was experienced from parasites or diseases because if the larvae in one unit became infected this condition could be easily checked before spreading throughout the rest of the culture.

As the adults and larvae require foods high in protein content a diet consisting of fish-scrap, salmon, cheese and bacon was fed. A layer of oily fish-scrap about ½ inch deep was spread over the bottom of the rearing chamber and served both as a food and as a carpet for the larvae to move about. The other foods were added as needed, i.e., salmon was fed to the larvae at first and when that had been consumed, cheese was added and so on in an effort to give some variety to the diet. The foods were not allowed to dry out, being kept in a fairly moist condition by adding water when it was needed. The cultures thrived exceedingly well on this type of diet. In fact, a very low mortality was obtained in breeding these insects with the exception of a few isolated instances when the larvae were attacked by parasites.

In starting a culture about thirty adult insects, equally divided as to sex, were placed in a container to which food had been added. Over a period of ten days about 150 to 200 eggs were oviposited. As this was about the maximum number reared in each container, the adults were taken out after this period and either used for further breeding purposes or for insecticidal tests. With the exception of feeding the larvae little attention was paid to the culture. The containers were cleaned out about once a month. This was accomplished by sifting out the fish-scrap with a No. 10 mesh sieve, the larvae, of course, were too large to get through the mesh. The tin cans were then thoroughly cleaned and a fresh layer of fish-scrap and other food added. The larvae were then put back into the containers and were not disturbed, except when food was added, until the adults emerged. In practice we started about three cultures a week which assured us of an ample supply of adults at all times. The adult insects were kept in separate containers with the exception of those used for breeders in starting new cultures.

VALUE OF *D. vulpinus* AS AN INSECT FOR BIOLOGICAL EXPERIMENTS

While the ease with which large numbers of these insects could be reared throughout the year was of importance, their greatest value lay in the fact that they were very resistant to toxic compounds and that variations generally met with in check and control experiments were for the most part negligible.

During the summer of 1926 a number of tests were made to determine the relative resistance of Dermestes vulpinus and other insects to compounds of known toxicity. Among the insects used were the common cockroach (*Blatella germanica* L.), the Japanese beetle (*Popillia japonica* Newn.), the Colorado potato beetle, (*Leptinotarsa decemlineata* Say), and the cockroach (*Periplaneta americana* L.). This series of experiments was made under the same conditions using direct contact sprays.

It was found after considerable study that *Dermestes vulpinus* was much more resistant to different contact sprays than the other insects used. It was also found that high mortalities which are often encountered in check and control cages while working with other insects was almost negligible with *Dermestes vulpinus*.

This insect also proved of value in determining the toxic value of compounds which were not readily dissolved in water or were poor emulsifiers. If such a compound could be dissolved in a volatile carrier such as petroleum ether its toxic valuation could be determined by spraying it on *Dermestes vulpinus*. Petroleum ether alone would cause a high mortality among some insects if they were thoroughly sprayed with it. However, in this case a mortality of about twenty per cent was obtained with the carrier alone with almost mathematical precision.

The adults and larvae were also used and found to be quite satisfactory in fumigation experiments. They were used along with the flour beetles (*Tribolium confusum* Fab.), the Indian meal moth (*Plodia interpunctella* Hbn.), the rice weevil (*Calandra oryzae* L.), the common bean weevil (*Bruchus obtectus* Say) and the pea weevil (*Bruchus pisorum* L.) and were found to be equally as resistant.

STUDIES IN BREEDING INSECTS THROUGHOUT THE YEAR FOR INSECTICIDE TESTS

III. Roaches, Clothes Moth, Weevils

By A. G. Grady, *Entomologist, Research Laboratories, Rohm & Haas Co., Inc., Bristol, Penna.*

Abstract

(A) Roaches (*Blattella germanica L.*) can be conveniently reared in large numbers by using a simple rearing cage which is described. The technique employed in rearing these insects is given.

(B) The webbing clothes moths (*Tineola bisselliella* Hummel) have been reared very easily in small containers housed in an insectary. The methods used in rearing large numbers of clothes moths is described.

(C) The common bean weevil (*Bruchus obtectus* Say), the rice weevil (*Sitophilus orysa* L.), and the confused flour beetle (*Tribolium confusum* Fab.) were reared in large tin drums kept in an insectary. The simple procedures employed in rearing these insects are given.

In studying the effect of various toxic compounds it was necessary to test them against many different insects in order to ascertain their value. For instance, a compound may be of little value when used as an "air-float" or as a direct contact spray but it may prove to be highly toxic when used as a fumigant. To insure a varied and plentiful supply of insects for biological experiments a study of breeding procedure was made and positive methods for the year around propagation of the following insects were developed: The house fly (*Musca domestica* L.), the leather beetle (*Dermestes vulpinus* Fab.), described in preceding papers, the Croton bug or german cockroach (*Blatella germanica* L.), the webbing clothes moth (*Tineola biselliella* Hummel), the common bean weevil (*Bruchus obtectus* Say), the pea weevil (*Bruchus pisorum* L.), the rice weevil (*Sitophilus oryza* L.), and the flour beetle (*Tribolium confusum* Fab.).

Little difficulty was experienced in rearing large numbers of these insects by the technique evolved and the testing of different compounds as contact sprays, fumigants, etc., was never held up because of a lack of suitable insects. As these insects are quite common and in some cases of great economic importance, their biology is too well known to warrant a description here.

(A) THE CROTON BUG (*B. germanica* L.)

To rear large numbers of cockroaches presents a difficult problem in that they are a hard insect to confine to any one place. Because of their migratory habits and their ability to escape through the smallest

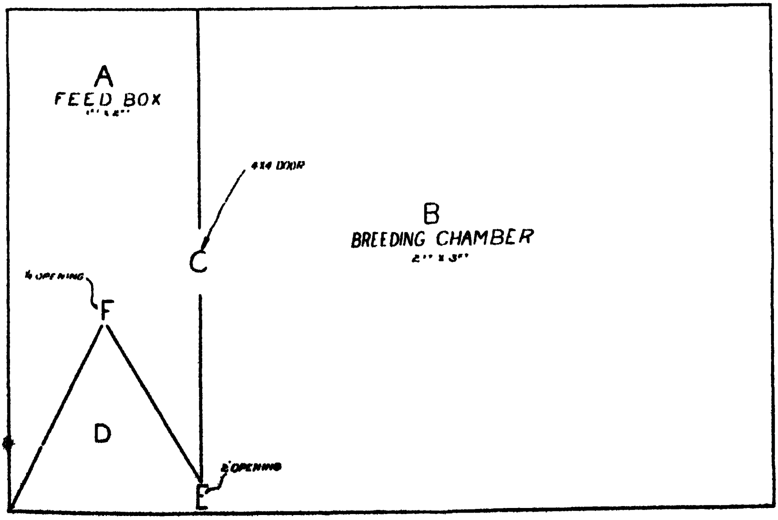

FIG. 43.—Plan view of breeding chamber for cockroaches.

cracks and crevices, unless a specially constructed cage is employed, these roaches will overrun an insectary and become a general nuisance in a very short time.

In an effort to keep these insects segregated, a rearing chamber (Fig. 43) 2 feet high by 4 feet long by 2 feet wide was constructed of matched lumber. This cage was made as tight as possible by caulking up all cracks and joints. The inside of the cage was partitioned off so that one-quarter (A) of it was used as a feed box and the other section (B), which was filled with loosely piled lath, served as a runway and breeding place for the insects. A small opening (C), about four inches square, was provided at the bottom of the partition which could be closed tightly by means of a sliding metal sheet. When open this gave the roaches easy access to both compartments. A V-shaped section (D) was built of ½ inch boards inside the feed box. This section had a two inch opening (E) leading from the large compartment and a very small opening or slit (F) at the junction of the two boards comprising the V. The insects could enter through the opening (E) into the V-shaped section (D) from the large compartment (B) and easily gain access to the feed box (A) through the small opening (F) at the junction of the two boards. However, once they got into the feed box it was difficult for them to find their way back to the large compartment provided that the entrance (C) in the other partition was closed. In this way, the roaches were easily caught when needed for insecticidal experiments. A door, 1 foot by 1 foot, was provided on the top of the feed box. This door was equipped with a felt strip, somewhat on the order of weather stripping, which served as an insect tight gasket. The construction of this type of cage was suggested by Dr. W. S. Abbott of the Bureau of Entomology.

A galvanized iron tray, 5 feet long by 3 feet wide, by 6 inches deep was made and filled with water to which some kerosene had been added. The rearing cage was then set on bricks in the tray, resting just above the water line. This arrangement provided a sort of moat which served very well to keep the insects that succeeded in escaping from the inside of the cage from getting into the insectary proper.

The roaches were fed sweetened bread and milk once a week and occasionally about 100 grams of yeast was added to the usual food supply. The inside of the cage was kept in a damp condition by wetting the section in which the lath was placed.

At a temperature of about 25° C., *B. germanica* will develop from the egg to the adult stage in about five and one-half months. As each capsule oviposited by the females contains about forty eggs, a very large culture can be reared in a surprisingly short time. We have reared many hundreds of these insects by the above method with excellent results. Losses of cultures through disease and attacks by parasites, which are often encountered in rearing other insects, were not experienced with roaches.

(B) THE CLOTHES MOTH (*Tineola bisellieella* HUMMEL)

The webbing clothes moth (*Tineola bisellieella* Hummel) was reared in large numbers and used extensively in fumigation experiments. Because the clothes moth is subject to attacks by mites and other parasites, the cultures were reared in separate units. Tin cans 10 inches in diameter by 8 inches high were used as chambers in rearing these insects with excellent results. These containers were provided with tight fitting covers in which small holes were punched.

The larvae were raised on a diet consisting of feathers and wool and a number of cultures were reared on dried squirrel skins. A culture of between 75 to 100 eggs and newly hatched larvae was introduced into each container. No attention was paid to the culture other than to watch that it remained free of parasites and that an adequate supply of food was on hand until the larvae had developed sufficiently to be used for fumigation experiments. Of course, a number of the larvae were allowed to develop to the adult stage so as to insure a sufficient supply of eggs and larvae for future cultures. In working with the webbing clothes moth, we have observed that, at a temperature of about 25° C., it develops from the egg to the adult stage in a little over three months.

(C) WEEVILS

The common bean weevil (*B. obtectus* Say), the pea weevil (*B. pisorum* L.), the rice weevil (*Calandra oryzae* L.) and the confused beetle (*Tribolium confusum* Fab.), were reared in containers in a greenhouse.

The common bean weevil was reared in great numbers in twenty-five gallon tin drums. These were provided with tight fitting covers in which holes had been punched and served very well as rearing chambers. About one-third of a bushel of infested beans was placed in each container. About every three or four months new food was added and the remains of the old beans sifted out. These cultures were reared in the outside insectary above described throughout the year. During the winter a temperature of about 18° C. was maintained in the greenhouse. Of course, the temperature inside the drums was much higher, a temperature as high as 35° C. having been recorded because of the heating of infested media.

The same technique was employed in rearing the pea and rice weevil and the flour weevil, except that peas were placed in the drums where the pea weevils were reared and corn on the cob was used as a food for the rice weevils. The confused beetles were reared on ground bran. All of these weevils were used in studying the toxicity of various compounds when used as fumigants.

STUDIES IN INSECTICIDAL ACTIVITY

I. Testing Insecticides Against Flies

By C. H. Peet and A. G. Grady, *Research Laboratories, Rohm & Haas Co., Inc., Bristol, Penna.*

Abstract

An attempt has been made to establish the testing of household insecticides on a sound and comparable basis.

The necessity for the reduction of variables to a minimum is pointed out and it is suggested that a definite standard be adopted for time, temperature, humidity, insecticide concentration, spray concentration, pressure in sprayer, air condition, angle of spray, kind of insect, and condition of insect.

Emphasis is placed upon the fact that many tests and extended observations are necessary and explicit directions for conducting tests upon flies are given.

Although a vast amount of work has been done on examining various compounds to determine their value as insecticides, the variations in the methods of testing these compounds and in the standards set up by the various investigators have made it almost impossible to draw valid comparisons between the results reported. In some cases insects have been tested by exposing them to the fumes of the particular compound being tested even though the compounds were relatively non-volatile and had to be heated in order to volatilize them. In others the compound being studied was dissolved in some oil carrier and dispersed by spraying. Still other determinations of insecticidal effectiveness have been made by completely immersing the insect to be tested in the material under consideration either at 100% concentration or at various dilutions. Obviously there is almost no common ground between these methods of testing. The desirability, however, of formulating some uniform testing procedure is evident and it is hoped that this series of papers will serve to stimulate other investigators to work upon this problem and to offer such alterations and improvements in technique as may seem desirable in order that insecticidal tests may be made sufficiently simple to be carried out in any reasonably adequate laboratory and sufficiently uniform to be quite strictly comparable wherever they may have been performed.

The most common pest the world over is the fly and the economic significance of the various species of stable flies is so well appreciated that a large program of research upon its control is being undertaken by the government. The annoyances caused by the house fly as well as the danger of infection due to its presence are pointed out in the advertisements of every magazine. The smaller and generally less prevalent fruit flies, gnats, etc., constitute a special problem in certain localities. Accordingly this first paper deals specifically with methods of determining the effectiveness of compounds against flies. There is, of course, a great variation in the resistance of the different families of flies to the action of insecticides, but the relative resistance of these various families follows approximately the same curve against all insecticidal compounds. Accordingly, once that curve has been established for all the families, which are sufficiently common to constitute pests, it is only necessary, in testing a new compound, to test it against one or two families in order to locate the curve of its efficiency. This paper makes no attempt to establish these curves but serves solely to point out a method of testing which is applicable to all families of flies and which can be followed by other investigators.

The determination of toxicity against insects must be a purely biological test and, like all biological tests, it is subject to the very considerable variability which accompanies the reaction of the living organism to external effects and influences. This variability is innate in all creatures and cannot be controlled but the superficial variables which have heretofore been ignored, or too little considered, can be so accurately controlled that only the biological variable remains to remove such tests from strict reproducibility and the average will be just as certain as life insurance mortality tables.

The variables which this investigation has shown to possess the greatest significance are: time, temperature, humidity, insecticide concentration, carrier, fineness of spray, air conditions, angle of spray and condition of insect.

It is obvious that it is unfair to draw a comparison between two insecticidal compounds one of which is allowed to work upon the insect for twice as long a time as the other.

The importance of temperature control may easily be demonstrated by exposing two groups of insects from the same brood to the same insecticide at say 60° F. and 85° F. The higher percentage kill among the insects in the warmer chamber will be quickly appreciated.

The influence of humidity on the resistance of the insect to toxic compounds has been too generally ignored in testing for insecticidal power. It does not have as great an effect as the temperature differential but it does exert sufficient influence to alter the results obtained with the same material in successive tests.

The fact that a higher concentration of material being tested in any given solution should produce a greater or more rapid kill does not require discussion.

The variations in effectiveness produced by variations in spray concentration are less easily demonstrable but undoubtedly just as certain for if the spray or vapor of any material under consideration be more attenuated in one instance than in another, there must be a higher concentration of insecticide in the area which has the greatest spray concentration.

Few carriers are inert but many studies have shown that there is a very considerable difference between the toxicity of these numerous relatively inert solvents.[1] Accordingly, if one investigator reports on an insecticide using as a carrier a certain fraction of Pennsylvania Oil, another on the same material using a corresponding fraction of California Oil, there will be a disagreement. Similarly, if one investigator uses a certain fraction of Pennsylvania Oil and another a different fraction of the same oil, they will obtain different results.

Griffiin, Richardson and Burdette[2] have shown that the size droplet produced by a sprayer has a very marked effect upon the insecticidal activity of the same material. Droplets of 5 to 10 mu produce about the maximum effect whereas droplets of 2 mu and smaller decrease the activity of the insecticide. These conclusions were based upon a study of contact sprays and insofar as the insecticide serves as a contact poison, they will apply to it. If, on the other hand, the insecticide functions in the vapor phase, the rate of evaporation will increase as the droplet size decreases and the reverse conclusion must be drawn. There are two ways of producing these variations in droplet size. One is by changing the type of atomizer or spray and the other by changing the pressure on the same sprayer. Since it is probable that the majority of tests will be made using the same sprayer, the variable which must be controlled is pressure.

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[1] Moore & Graham. A Study of the Toxicity of Kerosene, Jour. Econ. Ent., 1918, XI, 70-75.

[2] Griffin, Richardson & Burdette. Relation of Size of Oil Drops to Toxicity of Petroleum-Oil Emulsions to Aphids. Jour. of Agri. Research, Vol. 34, Pages 727–738.

By air conditions is meant whether the air is fresh or exhausted and whether it is stagnant or in motion. The factor of freshness can probably be ignored because the chamber is always aired between tests but whether or not the air in a testing chamber is motionless or well agitated does have considerable effect for two reasons. First, a given compound and its carrier may have a high specific gravity thus producing a higher concentration of insecticide in the lower part, that is, along the floor of the chamber, than at the top or it may tend to concentrate at the top. The resulting effect upon flies being tested will obviously depend upon the part of the chamber in which they remained. In a sense this factor is only an extension of the spray concentration factor.

The importance of the angle of the spray is also closely related to spray concentration. If the spray enters the chamber from all directions there is much more uniform dispersion of the material under study. Also, of course, this factor is of importance if the spray comes in contact with the insects. If the material being examined is heavy and is sprayed downward upon the fly it is possible that its wings will shield its body or perhaps it would be more correct to say that if the spray were directed upward against the fly there would be greater likelihood of its coming in contact with the more vital parts of the insect.

Condition of the insect is one of the most important factors to be considered. It requires no elaboration to point out that an old fly or a vitiated fly or a very young fly or a fly in any way enfeebled will be more susceptible to the action of any toxic material than will a strong healthy individual.

The method of testing which this paper wishes to advocate is as follows:

CHAMBER: All fly tests should be carried out under conditions which at least approximate those existing in the fly's normal environment and for this purpose a chamber of sufficient size to enable the fly to move about freely and approximately as unrestrictedly as it normally would should be provided. A very satisfactory size has been found to be a 6 x 6 x 6 foot cube. In the studies upon which this paper is based, this chamber was made of wood with the bracing members on the outside, leaving the inside as free from projections, corners, ledges, etc., as possible. The inner surfaces were originally well painted with white enamel in order to prevent absorption, by the wood, of material being tested. This paint, however, adsorbed and absorbed a certain proportion of the oily materials being studied and, although it was carefully wiped out after each test, it was impossible to remove all traces of the preceding materials. Accordingly, the inside, including floor and ceiling, was lined with transite board, an asbestos composition, all corners were sealed with a Silex sodium silicate cement and the walls were rendered as nearly non-absorbent to oils as possible by painting with sodium silicate. In the center of the ceiling a glass window was set with a bulb above it for illumination. A tight closing door, large enough for a man to enter, was set in one wall and the adjoining walls were provided with glass windows in the center of each. These same walls each had four square ports 6 x 6 inches covered with wire gauze and provided with tight fitting hatches. Each wall had two one-half inch holes bored through it six inches from the ceiling and closed by corks. Inside the chamber, on the floor, was set an eight inch oscillating fan completely enclosed by a guard of wire gauze.

PROCEDURE: Each test was run upon a considerable number of flies, never less than 100 and usually rather more but not exceeding about one per cubic foot. These were liberated in the chamber, which was kept at 85° F., the fan was turned on and the insecticide was introduced through the one-half inch holes along the ceiling by means of a modified Rexall Kantleek Atomizer No. R-1501. The modification consisted in replacing the reservoir of the atomizer by a narrow 20 cc. cylinder made by cutting off an ordinary burette and sealing one end and in substituting a sufficiently long outlet tube to reach practically to the bottom of the cylinder for the shorter one which is standard equipment. By reading the level of the liquid before and after spraying, the amount used can be very accurately determined. This atomizer was operated at 12½ pounds pressure from a constant pressure airline controlled by a reducing valve. The amount of solution used in each test was 12 cc. and this was sprayed in about equal quantities through each top hole. The door and all ports were, of course, tightly closed during this procedure. The chamber was kept closed for ten minutes during which time observations on the flies could be made through the windows to study the manner in which the material being tested was affecting them. At the end of ten minutes the square ports were all opened and the number of flies still clinging to the walls and ceiling was counted through the side windows. The flies which had dropped were carefully gathered up and transferred to clean cages made completely of wire gauze except for the bases. It was considered that the flies still off the floor had escaped the action of the insecticide. The flies in their gauze cages were kept for twenty-four hours to observe whether there was ultimate recovery or death. At the end of this period, these insects were counted and the number still alive added to those which had been on the walls of the chamber. As soon as the flies had been removed from the testing chamber a Buffalo Blower was turned on sweeping out the chamber by sucking air through it.

The variables thus far held in control are time, temperature, spray concentration, pressure in spray, air conditions, angle of spray, and kind of insect. The condition of the insect is more particularly dependent upon how it has been bred and this phase of the problem is discussed in a paper by Mr. A. G. Grady on the breeding of flies.

Tests conducted following this procedure show a low average variation and it is entirely reasonable to presume that any investigator could obtain very uniform results following the method.

STUDIES IN INSECTICIDAL ACTIVITY

II. Direct Contact Sprays

By C. H. Peet and A. G. Grady, *Research Laboratories, Rohm & Haas Co., Inc., Bristol, Penna.*

Abstract

A standardized method for testing contact sprays has been developed. The special test cages employed are described and the exact procedure followed is given in detail. An equation has been developed which expresses the effectiveness of the insecticide mathematically.

A special method is outlined for the testing of insecticidal powders.

The testing of insecticides which act by direct contact rather than by volatilization or by air float presents a special problem. The insecticide should be brought well in contact with the insect being tested, the viability of the insect should be definitely established, and the method of applying the insecticide should be quite strictly reproducible. The methods, which this paper advocates, involve testing the material under consideration in the form in which it would be applied in the household, namely, in oil solution and in a strictly inert carrier together with control tests to determine the normal mortality among unsprayed insects.

Insecticides of this type commonly do not have a very rapid action nor is rapidity of action required. The creatures against which they are used are generally creeping pests such as ants, roaches, millipeds, bedbugs, and various members of the coleoptera. Since it is, of course, impossible to test any given material against all the types of insect which it might destroy, the first step is the choice of a reference insect. This laboratory has found the common cockroach (*Blatella germanica*) and the ordinary leather beetle (*Dermestes vulpinus*) easily bred under artificial conditions and possessed of sufficiently short life cycles to serve as excellent test insects.

TESTING THE FINISHED INSECTICIDE

The test chamber employed consists of a box of wire gauze approximately 8 by 8 by 8 inches. It is made from a block of 1 inch pine to one edge of which are nailed two 1 by 1 inch uprights, 8 inches long, connected by an 8 inch crossbar. To each of the upper corners of the frame a thin oak strip, 1 inch wide, is nailed and bent in practically a quadrant until it meets the base where it is attached. Grooves cut in the upright frame permit a plate of window glass to slide up and down and the rest of the box is covered with 16 mesh wire gauze. Such a chamber makes it possible to spray the insects contained in it from practically all directions and affords them practically no covered corners in which they can hide and avoid the spray. Because insects of this type are reared with difficulty in batches of uniform age, the method of probabilities is employed and from 50 to 100 insects of the kind being tested are transferred from the large breeding cage to each test cage. Five test cages are employed for each test; two of them are lethal chambers and three are check cages. One of the checks is a starvation cage, in which from 50 to 100 insects are placed with no food; in the second, approximately the same number of insects is placed but an adequate supply of food is provided; in the third, about the same number of insects is introduced and these insects are used to test the toxicity of the carrier being employed.

PROCEDURE: The same precautions with regard to fineness of spray, which have been emphasized in a preceding paper, (Studies in Insecticidal Activity—I. Testing Insecticides against flies,) should be observed. The spray is directed upon the insects from every possible angle until each insect has been thoroughly wet all over. This is not, however, to be interpreted to mean that the insects are to be drenched to the point of drowning. The insects in the third check cage are then sprayed in the same manner with the hydrocarbon or other carrier alone. After spraying is complete the proper food (salmon, cheese or other protein material in the case of the dermestidae and bread and milk in the case of cockroaches) is put in each cage on a flat dish in order that the food may not absorb insecticide. For comparisons among the cages of any single test group it is sufficient to have the series of cages being tested in the same room on the same bench. This gives sufficiently uniform external conditions. The uncertainty of obtaining insects of the same viability from week to week makes it preferable to run a fresh series of tests on any given compound when comparisons are desired. If, however, it is desired to compare one day's tests with another, it is essential that the test cages be kept in a room of uniform temperature. Such tests can be made by employing a room similar to the insectary described in a previous paper from these laboratories.[1]

It is obvious that the three check cages set up on any day may serve as controls for as large a series of test pairs as may be set up.

INTERPRETATION: If C is taken as the per cent of insects living in the feeding control cage and T is the percentage alive in the test cages, then

$$100\frac{C-T}{C} = I$$

the insecticidal coefficient of the finished insecticide and the lower the coefficient, the less effective the insecticide. To obtain the insecticidal coefficient of the insecticidal principle apart from its carrier, the equation is modified to

$$100\,\frac{S-T}{S} = I_p$$

in which S is the per cent alive in the carrier control cage, I_p the insecticidal coefficient of the insecticidal principle, and T is again the percentage living in the test cages.[2]

One method of arriving at the insecticidal value of a given compound has been outlined just above. Two others are possible.

(1) If the material being tested is a liquid it can be emulsified in water and this emulsion can be sprayed exactly as described under procedure above. Such emulsions are difficult to make with water alone as the dispersing medium so it is commonly better practice to employ an emulsifying agent. For this purpose soap solutions have proven very generally satisfactory. In such a case, however, the insecticidal action of the soap must be taken into consideration and evaluated as hereinbefore described. Tests in this laboratory indicate that saponin is a more satisfactory emulsifying agent for tests in that its effect upon insects is practically negligible. Its chemical inertness is also a desirable feature in the case of compounds possessing alkali sensitive groups. The only accessory or synergistic component in this case is water.

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[1] Studies in Breeding Insects Throughout the Year for Insecticide Tests. I. House Flies (*Musca domestica*).

[2] Effectiveness against the San Jose Scale of the Day substitutes for Liquid Lime Sulfur. Abbott, Culver and Morgan, Dept. of Agr. Bulletin No. 1371, pp. 6.

(2) For compounds which are solid or which it may be preferable to apply in powder form a different procedure is necessary. Two general methods are suggested. A group of insects (and the number should not be too small) may be placed in a can and sprinkled with the powder until enough powder is spread over the bottom of the can to make it possible to give each insect a thin coat of the powder by shaking the can about. This method insures a fair test of the insecticide but does not in any way approximate the conditions under which the insecticide is normally employed. It is the opinion of these laboratories that tests should be designed to approximate more closely the conditions under which the ultimate consumer applies the insecticide. Accordingly, the methods which have been followed here have been somewhat more rigorous.

If the insecticidal powder is designed to be sprayed or blown upon the insect, the insects are placed in the opening of a V-shaped runway which has a trap at the narrow end and the powder being tested is blown against them. They are then carefully brushed into the trap and the time required for the insecticide to produce death is observed. At the end of 24 and 48 hours the number of insects still left is counted and the efficiency of the insecticide at the expiration of these periods is calculated by the application of the formula developed above. For this test, if a diluent is employed, a check test on the diluent is also made under similar conditions to the test proper. Of course feeding and starvation checks must also be run in connection with these tests or the equation is not applicable.

If the insecticide is designed to be spread in cracks or across runways, a method has been developed which closely approximates the conditions existing in actual use. A 6 inch square of 1 inch pine is enclosed at a distance of 6 inches by a retaining wall of 1 inch strips. The bottom of the moat thus formed between the island in the center and these retaining strips is covered with a layer of the insecticide to be tested. Insects are then liberated on the island a few at a time and lured across the moat where they are captured and placed in small cages. These caged insects are counted at the end of 24 and 48 hours and the insecticidal coefficient is calculated as above.

In conclusion it must be noted that the number of insects employed in each test must not drop below the minimum of about fifty for, as we have pointed out in previous papers, the dependability of a biological test is always closely related to the number of tests run.

STUDIES IN INSECTICIDAL ACTIVITY

III. TESTING INSECTICIDAL FUMIGANTS—I.E., INSECTICIDES WHICH FUNCTION IN THE VAPOR PHASE

By C. H. PEET and A. G. GRADY, *Research Laboratories, Rohm & Haas Co., Inc., Bristol, Penna.*

ABSTRACT

An exact procedure for the testing of insecticidal fumigants for use in (A) storage warehouses and (B) grain elevators, etc., is described.

Comprehensive studies have been made by Roark and Cotton,[1] by Hoyt[2] and others upon the use of various compounds and mixtures as insect fumigants, and the authors of this paper have drawn freely upon their published work, as well as upon private communications, in developing the testing procedure advocated and described herein. It is obvious that a considerable degree of uniformity will run thru entirely independent work of this sort, but certain divergencies appear, and it is the purpose of this paper to present an easily reproducible standard method of testing which may be employed by anybody anywhere with the assurance that the results will be strictly comparable.

The use of fumigants in insect control is confined, of course, to warehouses and storehouses of various sorts, and tests to determine the effectiveness of compounds as fumigants must simulate actual conditions closely. It is impossible to make a quantitative test in a can or small box tho such a test may serve to give useful qualitative data, and the results obtained may indicate the amounts which will be required for quantitative tests. The insecticide, which is employed, must be volatile and possess the property of penetrating deeply into rather closely packed material, and in the test the insect should be given the protection lent by a layer of the material in which it would be found. The insects which are the most common warehouse pests, grain weevils and moths, should be employed in studying the value of an insecticide as a fumigant.

(A) TESTS ON FUMIGANTS FOR STORAGE WAREHOUSES, ETC.

In a chamber of not less than about 200 cubic feet capacity are placed four boxes, each containing a layer of woolen material, then a colony of moths and larvae numbering about twenty-five, and over this firmly tamped down a top layer 4″ thick of either woolen or cotton waste. The exact size and shape of the chamber is immaterial, but it should be tight. The fumigant is introduced thru ports in such a manner that the insecticide itself does not drop upon or come in direct contact with the moth culture. With gaseous fumigants no such precaution is necessary but with volatile liquid fumigants a shield must be interposed between the spray and the moth culture, if a spray is employed. If direct volatilization from a container within the chamber is relied upon, the use of such a shield is unnecessary. The temperature of the chamber must be kept uniform in order to make successive tests comparable, and a temperature of 80° is very satisfactory. Tho the importance of humidity appears to be less marked than in the case of insecticides designed for use against flies and similar household pests, the importance of temperature control is equally great, for a fumigant increases in activity as the temperature at which it is employed rises. The concentration of fumigant in the testing chamber must be definitely known in order to make tests comparable. If all the tests are run in the same chamber, it is sufficient to know the number of grams used in each test, but for purposes of comparison it is necessary to express the concentration of the fumigant in terms of weight per volume, i.e., grams per cubic foot or such other units as may be preferred. From an economic standpoint the ratio between effective concentration and cost is significant and should undoubtedly be the final basis of comparison, but, once the effective concentration is known, each user can easily calculate this ratio for himself.

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[1] Jour. Econ. Entomol., *20*, 636, 1927; Jour. Ind. and Eng. Chem. *20*, 512, 1928; U. S. Department of Agriculture Bulletin No. 1313—Neifert, Cook, Roark, Tonkin, Back, Cotton—Fumigation against grain weevils with various volatile organic compounds.

[2] Jour. Ind. and Eng. Chem. *20*, 460, 1928.

The test period adopted is twenty-four hours, because it is seldom possible to run two fumigations in one day in commercial warehouses. At the end of the test period the box of wool is removed and the insects in it are counted. The minimum concentration in grams per cubic foot which will give 100% kill is determined, and this value is called the "fumigation factor" at that temperature for the material being tested. This fumigation factor is never based upon less than two such tests for reasons which have been pointed out in previous papers.

(B) GRAIN FUMIGATION

Fumigation of grain or flour is usually carried out in elevators or in warehouses in which the material is stored in bags or in bulk. If the fumigant is lighter than air, it should be introduced at the bottom of the room which is being fumigated, and, if the fumigant is heavier than air, it should be introduced from the top. Practically, if the fumigant is non-toxic to man and sufficiently volatile to leave no objectionable taste or odor on the material being fumigated, it is probably satisfactory simply to spray or pour it upon the grain which is being fumigated. In the case of smaller scale tests, it is a fairer measure of the insecticidal efficiency of the fumigant to employ it in its vaporized condition.

To test the value of a fumigant in destroying grain pests, a small sack about 4 x 4″, made of some very loose material such as burlap, is filled with grain (wheat or rice) containing about one hundred grain weevils. This sack is placed in a basket of grain and covered to a depth of 6″ with the grain. Four such baskets are placed in the fumigating vault and the fumigant is then introduced exactly as in the case of warehouse fumigants. The temperature is held at 80°, and the chamber is kept closed for twenty-four hours, at the end of which time the buried culture is removed and the insects counted. As in the preceding instance, the minimum concentration in grams per cubic foot which will give 100% kill is taken as the "fumigation factor" at the temperature employed, and this factor is never accepted on less than two tests, i.e., eight checks.

As a fumigant for ground grain (flour, bran, etc.), a similar sack about 3″ square, containing bran and weevils, is buried 4″ below the surface of a sack of bran, which is then tied at the neck. At the end of the twenty-four hour test period the sack is removed and the insects in the smaller sack are counted.

Where the effectiveness of the fumigant is below 100%, these testing methods do not give strictly reproducible results, but, when the concentration of any fumigant required to give 100% kill has been determined, this same concentration will uniformly give the same percentage of kill.

Attention should be drawn to the fact that the tests, herein described, are made under ideal conditions, the temperature being held constant and the chamber being airtight. As Hoyt[4] has very correctly pointed out, the conditions existing during actual fumigation are far from ideal, due to variable temperatures and, in probably even larger degree, leakage of the insecticidal fumigant. Control of these factors is of the utmost importance in determining the relative value of fumigants, but the fact that this cannot be realized practically must be recognized by users of this type of insecticide in order that the same efficiency shall not be expected in actual practice as in tests under rigid control.

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[4] Jour. Ind. and Eng. Chem. 20, 460, 1928.

STUDIES IN INSECTICIDAL ACTIVITY

IV. Testing Insecticides as Insect Repellents and Moth Killers

By C. H. Peet and A. G. Grady, *Research Laboratories, Rohm & Haas Co., Inc., Bristol, Penna.*

Abstract

Tho ants, roaches and other insects are repelled by certain substances, this paper concerns itself solely with moth-proofing and moth-killing tests. A detailed description is given of the procedure followed in testing compounds recommended for either purpose.

The utilization of repellents for the prevention of insect infestation is confined almost entirely to the proofing of materials against the attack of moths. A measure of success has attended the prevention of inroads of ants and roaches by certain substances, but there is no reasonably exact method for determining the extent to which any given repellent discourages the intrusion of these insects. It is known that some substances sprinkled or sprayed upon the runways of ants cause them to forsake these paths and the subject is one well worth further investigation. But, in order to determine the effectiveness of such a repellent, a dependable method of testing repellency must be evolved. However, the effectiveness of a moth proofer is not difficult to determine.

The material in question should be uniformly distributed over a piece of woolen goods, and the amount of repellent is calculated upon the weight of the goods. The method for determining this concentration is as follows:

The repellent, which is being employed, is dissolved to a known concentration in the proper solvent which may be water, some organic solvent or an acid or alkali. The previously weighed goods is dipped into the solvent and squeezed out until it no longer drips liquid and is hung up to dry. The decrease in the volume of the repellent solution will tell how much of the repellent has been distributed over the cloth. A few experiments make it possible to calculate quite accurately in advance just how much solvent will be taken up by a given weight of cloth and accordingly the concentration of repellent, which must be used in the solution, can be calculated.

In the case of certain moth proofing agents (we refer particularly to the alkaloids which have been recently suggested for this purpose), dipping the material will result in an action upon the material similar to dyeing, that is, an actual physico-chemical adhesion of the repellent to the fibers of the fabric. Such an action will result in exhaustion of the bath out of proportion to the amount of solvent absorbed. In such cases the final concentration of the bath can be determined by chemical analysis and the amount absorbed must be calculated by difference. After drying, the fabric is cut up into approximately 2 inch squares and 5 larvae are placed on each of six such squares. No attention need be paid to adult moths as it is the larvae which do the damage. Each sample is put in a small flat dish upon which a screen cover is laid. At the end of 48 hours each square is examined. The only satisfactory measure of moth proofing efficiency is the absence of holes in the fabric or destruction of the pile.

The method, which we employ, is to find the minimum concentration required to prevent moth larvae from feeding. This concentration for any known substance, compared with the concentration of any other, is the relative measure of the efficiencies of the two.

The prevention of moths by the employment of substances, which give off vapors which kill moths or larvae or eggs or repel moths and larvae, is the other common method of combating these pests. The procedure used for these tests depends upon whether the material is being tested as a moth repellent or as a moth killer. In the former case, a colony of moths, larvae and eggs is placed in a can about 10 inches high by 8 inches wide, which has a wire gauze cover. Into the can are introduced six 1 inch squares of pure woolen cloth and a seventh square of cotton cloth, dipped in the material being examined, is placed in the same can. The can is then stored in an insectary or incubator and kept at 85° F. At the end of 10 days the woolen squares are examined. If they are unmarked by the inroads of the larvae, the material being tested is considered satisfactory. Search is made for fresh eggs and the number of larvae is counted to determine whether or not the material was lethal as well as repellent. In the second case, i.e., when the material is being tested as a moth killer rather than as a moth repellent, the same procedure is followed but the can is opened at the end of twenty-four hours and the reciprocal of the number of insects and larvae alive is considered the measure of the effectiveness of the insecticide.

A FOREIGN BOOK PEST ENTERS BOSTON

By Raymond L. Taylor, *Bussey Institution, Harvard University*

ABSTRACT

A tropical Anobiid, *Catorama* species, inflicted severe damage to a large shipment of books from Honolulu to Boston. Larvae have been active and have fed for at least seven weeks in Massachusetts at room temperatures, and the possibility of infestation of heated libraries throughout the city is advanced as adequate justification for a thorough carbon bisulphide treatment of the infested stock.

Since so many of the most destructive insect pests of the United States are exotic in origin, and also, since so many of these undesirable immigrants have entered the country in an unostentatious manner, the arrival, however quiet, of any foreign insect with a bad record should be of wide interest. Such an insect, a *Catorama* species, family *Anobiidae*, entered Boston, undetected, in early December, 1927.

Book pests, of which there are only a few, relatively, are usually not considered, under ordinary conditions, to cause any great injury to the libraries of the United States, and this view is, perhaps, a correct one to apply to the book Psocids, the silverfish, et al. This opinion was shared and thus it was amazing to see the condition of some 8,000 volumes, the contents of a 29 case shipment from Honolulu to N. J. Bartlett and Co., a Boston firm of booksellers. The shipment, which contained a number of rare editions and was conservatively valued at above $25,000, was extensively damaged. Help in the matter was asked and the damaged stock was inspected. When the books were unpacked, although the newspaper wrappings showed no evidences of injury, there was scarcely a volume of the collection not riddled by larval galleries and exit holes. While some of the books had but a few holes, the majority had the covers, at least, well perforated, and some of them were rendered virtually illegible throughout. It was significant that the damp books, marked by a brown mold, were comparatively immune from severe injury, and also noteworthy, that the insect showed a decided preference for the cardboard in the covers and for old, hand-made paper, rather than for modern, clay-filled and chemical-laden paper. There was remarkably little frass considering the amount of mining, and the insects which caused the injury were not readily visible. Indeed, this latter point was a mystifying feature of the problem. The books, the former library of the late Dr. William T. Brigham, Director of the Bernice Pauahi Bishop Museum, Honolulu, Hawaii, and a noted bibliophile, were in presumably perfect condition prior to boxing and storing some two to three years ago, and since all the extensive damage had, by presumption, occurred in that interval, there should have been ample insect remains. The probable solution of this was found and will be mentioned.

A preliminary search for the cause of the destruction, after an examination of at least fifty books, yielded three living larvae and the intact bodies of two, dormant or dead, adult beetles. These latter were determined as a *Catorama* species by Mr. C. A. Frost. A review of the literature inspired the conclusion that this insect was either *C. herbarium* or *C. mexicana* and at the same time, because *C. mexicana* was not listed in Junk's Coleopterorum Catalogus nor found elsewhere, it raised the interesting point that these two species might be synonymous. Sharp in Fauna Hawaiiensis ascribes *mexicana* to Chevrolat, who likewise is credited by Gorham, in his Biologia Centrali-Americana, with the naming of *C. herbarium*. The species, *herbarium*, was first taken in Mexico. An error in transcription, once made, might easily be perpetuated indefinitely, or until the genus was revised. In any event, both of these beetles, *C. mexicana* in Hawaii and *C. herbarium* in the West Indies and Brazil, are reputed to be highly destructive to books, leather goods, upholstery, and the like.

The living *Catorama* larvae were placed in a cork-stopped glass vial and observations were made. It was learned first, that the larvae ate their dead companions, although it is impossible to state whether or not they kill each other for that purpose. The larvae also consumed the bodies of adult beetles. This cannibalistic habit, if at all general, would adequately account for the surprisingly few insects found in the books examined, in proportion to the extensive mines, and with a consideration of the probable elapsed time of two to three years. It was also found that the larvae evidently preferred the protein of their companions, and the cork of the stopper, to the hand-made paper given them for food. Perhaps the most significant fact of all, however, is that these larvae have lived at least seven weeks in Massachusetts at room temperatures of from 40 to 65 deg. F. Living larvae continued to be taken from the books of the shipment. There arose at once the serious possibility of the destruction of books in libraries which are heated in winter, should this insect be introduced. The prospect, if improbable, was sufficiently grave so that it was agreed to subject the infested shipment to a program of thorough fumigation with carbon bisulphide. It would seem a safe rule, that, in general, any immigrant insect with destructive proclivities should be regarded as dangerous, and treated as such, at least, until all of its habits are known and its potentialities duly measured.

A more complete account of the above is in process of preparation.

SOME ADDITIONAL NOTES ON THE PINE-NEEDLE MITE, *ERIOPHYES PINI* NALEPA[1]

By Eric Walther[2]

Abstract

A few additional items of information about this pest have now become available. The mite appears to be rather widely distributed and seems to be carried over short distances by the wind. The carriage by man of cut branches and young trees seems to account for its sudden appearance in new localities. Spraying has been fairly successful on a small scale, but careful reforestation seems to promise the only permanent cure, providing only clean young trees are planted after previous removal of all infested pines.

Introduction

In view of the growing importance of the Monterey Pine, *Pinus radiata* Don, as a timber-tree in many parts of the world it seems advisable to publish all available information about the Pine-needle Mite, even though this last may seem to be a rather unimportant and obscure pest. This very obscurity of its habits often has delayed its discovery, even though present in some cases for many years, and certainly demonstrably injurious. In submitting the following notes the writer wishes to apologize for their brevity and incompleteness, the press of other work having prevented more thorough investigations and experiments. The previous paper mentioned under footnote (1) holds good with the exceptions here given.

Hosts

A corrected list of host-plants and their localities, as known to the writer, today stands as follows (See footnote 3):

Location:	Host-plant:	Reported by:
San Francisco, Calif.	*Pinus radiata.*	E. Walther
Golden Gate Park, Lincoln Park	" "	" "
Harding Park, Bay View Park	" "	" "
Presidio, Spring Valley Lands, etc.	" "	" "
Alameda Co., Calif.	" "	" "
Campus, University of California, Berkeley, etc.	" "	" "
Los Angeles, Elysian Park	" "	" "
Riverside, Calif.		
Near U. C. Citrus Experiment Station	" "	" "

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[1] For previous article on this subject by the writer see Journal of Economic Entomology, December 1925.

[2] Published by permission of John McLaren, Superintendent, Golden Gate Park, San Francisco, Calif.

HOSTS (*Continued*)

Location:	Host-plant:	Reported by:
San Diego, Calif., Balboa Park	*Pinus radiata.*	W. F. Swingle
Del Mar, San Diego Co., Calif.	" *Torreyana.*	" "
Truckee, Calif.	" *Jeffreyi.*	E. P. Felt (E. Bethel)
Southeast Ohio and N. Carolina	" *echinata.*	B. W. Wells
(In *Psyche*, 1921, as *Eriophyes sp.*)		
Central Europe	*P. sylvestris, P. laricio, P. cembra.*	Dr. Nalepa

Near Monterey, California, where *P. radiata* is indigenous, forming extensive, pure stands, a rather cursory examination failed to show any evidence of the mites presence, all cases of leaf cast noted being due to other causes. This would indicate that some other species of pine is the original host of the mite.[3]

HABITS

It seems certain that, at least in all locations observed by the writer, the mites do not hibernate within the buds, but may be found at all times, dormant or active, within the basal sheaths of the needle-clusters. Where the winters are colder, though, this may not hold good. The galls reported to be made by this mite in Europe, in Ohio and N. Carolina and at Truckee, Calif., may also very well represent its reaction to a more severe climate, if indeed it be the same species.

DISTRIBUTION

Contrary to previously expressed hopes even quite young pine-plantations may become affected early if there are any infested trees near by. The rapidity with which young plantations become infested seems to vary, inversely, as their distance from mite-infested pines. A wind strong enough to carry green needles is apparently needed to spread the mites. Young plantings usually become first affected on the side towards the most commonly prevailing winds, providing mite-infested pines are to be found in that direction. Where a young plantation, remote from old, infested trees becomes affected the young trees in question will often be found to have come from a nursery having one or more mite-infested pines in its vicinity.

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[3] Since this was written in the early part of 1927 the writer has been able to establish the presence of the mite on the Monterey Pine, *Pinus radiata*, throughout nearly the entire natural range of that species, having found it it Monterey, Del Monte, Carmel, Pebble Beach, as well as in the stand of the species near the line between San Mateo and Santa Cruz Counties. In the latter county it was also found on indigenous trees of *Pinus attenuata* and *P. ponderosa*. In Southern California it was also noted on *P. pinea* at Pasadena and on *P. canariensis* at Santa Monica.

This very wide distribution of the mite may possibly make the sanitation and quarantine-measures suggested difficult of execution, and should cause renewed efforts to either find some practicable method of control by spraying, etc., or to perhaps discover some natural enemy capable of reducing the numbers of the pine-needle mite to the point where it shall cease to produce any serious injury.

CONTROL

Until reforestation makes possible the real elimination of the pest some temporary control may be attained by spraying. The following figures may prove of interest; and represent the average of a large number of counts made September 17, 1927, six months after spraying once with a 6.66% Lubricating-oil emulsion.[4]

A. UNSPRAYED TREES: Number of needle-clusters infested	90%
Difference of infestation between older and younger needles	20%
B. SPRAYED TREES: Number of needle-clusters infested	55%
Difference of infestation between older and younger needles	50%

By the older needles are meant those that grew first, at the beginning of spring, while the younger ones matured towards the end of the growing season. On an unsprayed tree the latter are almost as heavily infested as the former, even though these last became infested much sooner. The reduction in number of younger needle-clusters infested on sprayed trees is entirely due the spraying done. This conclusion is borne out by some further, incomplete, and perhaps even more promising, tests, which indicate that spraying may produce very appreciable results if begun early, before the new growth becomes infested. The application may have to be repeated, and some doubt remains whether it might not be advisable to make lighter, more numerous applications. While the 6.66% Oil-spray seems to produce very lasting effects, the oil-film remaining visible, and actively protective, for quite a long time, this heavy dosage may in the end injure the pines, perhaps as much as the mites would have done.

SUMMARY

While it may not be impossible to check an infestation after its start by the prompt removal and destruction of all pines affected throughout the plantation and its neighborhood, the destruction of large numbers of trees is a drastic measure and represents an economic waste hard to justify, especially in view of the obscurity of the mite and the insidious nature of its work. As it remains yet to be demonstrated whether any real, lasting control of the mite may be attained by spraying it would seem wise to plant only clean young pines, grown in clean nurseries in mite-free localities, making previously sure that no mite-infested trees remain to reinfest the new plantations. The enforcement of rigid quarantine-measures with rigid inspection also seem essential if the further spread of the pine-needle mite is to be checked. If these precautions should prove insufficient the only alternative would appear to be the choice of some trees other than pines for reforestation (See footnote 3).

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[4] Standard Oil E. Stock, about 22° Baumé.

TROPIC RESPONSES OF CODLING-MOTH LARVAE

By N. E. McIndoo, *Entomologist, Deciduous-Fruit Insect Investigations, Bureau of Entomology, Washington, D. C.*

Abstract

In order to throw light on the biology of the codling moth, a thorough investigation of the tropisms of this insect was begun in the spring of 1927 at the suggestion of Dr. A. L. Quaintance in charge of Deciduous Fruit-Insect Investigations, Bureau of Entomology. Definite results were obtained by using only the larvae. In all 154 larvae, belonging to both broods, were tested individually in the laboratory under various conditions.

In bright light, although not direct sunshine, larvae of the first instar are weakly photopositive; that is, they go toward light. The following tests indicate how they find food under natural conditions. Twelve cubes of apple, each 4 or 5 millimeters in size, were placed about 1.25 inches apart on a paper inside a circle having a diameter of 5 inches. The paper lay on a table by a south window. Larvae were then placed, one at a time, inside the circle and allowed to search for the pieces of apple while slowly moving toward the light. Pieces of cork of the same size and squares drawn with a pencil inside the circle were used as controls. Larvae went to the pieces of apple 67 per cent of the chances offered them; to the pieces of cork, 50 per cent; and passed over the squares 30 per cent. These results indicate that smell and sight aid in locating objects. This method also suggested how attractants and repellents might be tested, but no definite information on this point was obtained, except that the larvae were found to be easily repelled and attracted with difficulty. Since larvae of the first instar have photopositive eyes they remain in the open and search freely for food, apparently not being aided by their sense until within a few millimeters of the food, because in the tests they wandered about aimlessly and did not perceive the pieces of apple and cork until near them, when they often turned and went directly to them.

Larvae of the second, third, and fourth instars are weakly photopositive to weak light, but indifferent to strong light. Larvae of the fifth instar sometimes act indifferently to light but generally are weakly photonegative; that is, they go away from light. Larvae of the sixth instar are either weakly or strongly photonegative, the degree depending on their age; and those with blackened ocelli did not respond to light. At cocooning time the larvae are strongly photonegative, geopositive, and thigmopositive, whereas during their earlier instars they behaved either indifferently to light, gravity, and touch, or were photopositive, geonegative, and thigmonegative. Consequently, when the larvae are ready to spin cocoons they avoid bright light as much as possible, usually move toward gravity, and hunt for dark and tight places in which to pupate. When bands are used as a supplementary control method we are merely taking advantage of nature's laws. It therefore seems that the vulnerable period in the life history of adult larvae is brought about by a change in tropisms.

(Withdrawn for publication elsewhere)

A VIAL FOR CATCHING SMALL LEAPING INSECTS

By MILTON F. CROWELL, *North East, Pa.*

ABSTRACT

By fitting a cone of fine wire screen, with an opening in the apex, into the open end of a vial, one can prevent the escape of small leaping insects caught in the vial. This is an advantage when collecting such insects alive.

A short time ago the writer had occasion to capture alive some specimens of the grape leaf-hopper, *Erythroneura comes* Say. These insects leap quickly and are difficult to catch in a vial. When in the vial they leap about vigorously, and often will escape when the vial is opened for the purpose of catching others.

The vial figured here was designed to aid the collector by allowing him to give his efforts to the capturing of the insects, and permitting him to take his attention from the matter of keeping those once caught.

A shell vial three inches long and three quarters of an inch in diameter was used. Into the open end of this was fitted a cone of fine copper screening, having an opening in the apex.

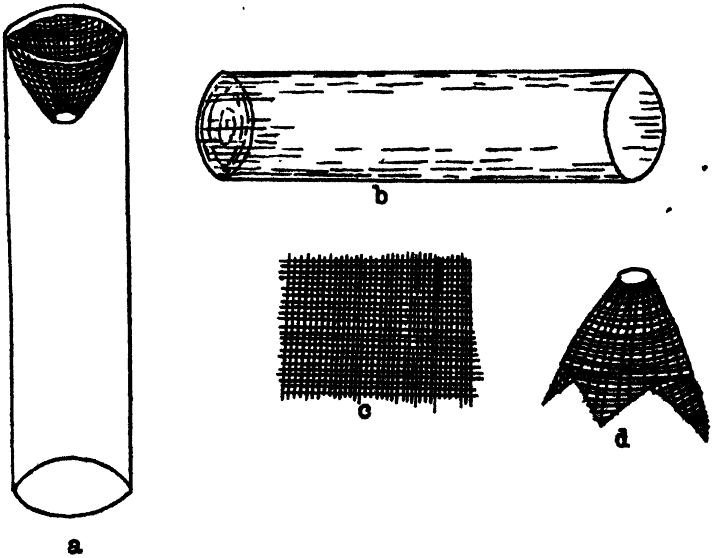

FIG. 45.—Vial for catching small hopping insects: *a*, completed vial; *b*, shell vial; *c*, small piece of screen; *d*, screen cone before fitting in vial, with corners untrimmed.

The cone was made by taking a small square of screen and forcing it into the opening of the vial by applying pressure to the center of the screen. When the cone was thus shaped, a small hole was cut in its apex. The cone was then placed in the vial again and the corners of the screen trimmed off. The cone can then be forced a little way into the vial, remaining in place by the spring action of the bent wire against the side of the glass. Care should be taken not to make the cone so small that it will drop out.

While not perfect, a few hoppers will escape even from this, this arrangement made the catching of leaf hoppers comparatively easy. The vial would be useful for such insects as flea-beetles as well.

Scientific Notes

Sexual Color Variation in *Heliothis obsoleta* Fab. So far as can be ascertained, writers on *Heliothis obsoleta* Fab. heretofore have not considered color differences in the moths of this species as specific sexual characters. That these color variations of the moth were recognized is evidenced by the fact that they have been treated as varietal characters. According to about 100 dissection records and over 1,000 oviposition observations made at Baton Rouge, Louisiana, during the fall of 1926 and 1927, all individuals formerly considered as belonging to the variety *ochracea* Ckll. were found to be females, while all those of the variety *umbrosa* Grote were males.

While individuals of both sexes may vary in degree of color as regards lightness or darkness, the sexual color remains constant. The female is always a tawny colored yellowish-brown, while the male has an olive-green tint. An excellent illustration of this sexual color differentiation is given in Kentucky Bulletin No. 187, Plate I, by Garman and Jewett. This plate shows quite clearly forms which according to our observations are a typical male and female under the legend "Color variation of *imagoes*."

Quaintance and Brues in Bulletin No. 50, Bureau of Entomology, U. S. Department of Agriculture, state: "More of the females fall in the *ochracea* group and more of the males under *umbrosa*." It appears from this statement that these color differences were not recognized as strictly sexual characters, although the authors noticed a relationship between color and sex.

The conclusions of these observations have been referred to and substantiated by Mr. Carl Heinrich and Dr. H. G. Dyar after a study of the literature on this group and the material contained in the collections of the National Museum.

C. E. SMITH and NORMAN ALLEN, *Baton Rouge, La.*

A New Method of Using Fish-oil as an Adhesive. An adaptation of the use of fish oil as an adhesive, as worked out by Hood for use in spraying with arsenate of lead for the gypsy moth, has been developed at the laboratory of the Bureau of Entomology at Vincennes, Indiana, and is here mentioned as of possible interest to other entomologists.

As now recommended, the fish-oil is poured directly into the spray tank, and is mixed with the insecticide by the action of the agitator. A more intimate mixture of the fish oil and arsenate of lead appears to be obtained by first making a paste, taking advantage of the fact that arsenate of lead, like most finely divided solids, is an effective emulsifier, and may be used to emulsify the fish oil. The following proportions have been used:

Arsenate of lead	8 lbs.	
Water	14 lbs.	(About 7 quarts.)
Fish oil	2 lbs.	(About 1⅞ qts.)

The arsenate of lead and water are first thoroughly mixed, the fish oil is added, and the whole pumped two or three times. The arsenate of lead appears to form a very stable emulsion of the fish oil, which in this case contains approximately 33 per cent of arsenate of lead by weight. The proportions may doubtless be varied to suit the equipment used in mixing the material, although as the quantity of water is cut down it becomes increasingly difficult to force the paste through the ordinary pump.

Preliminary observations indicate that arsenate of lead prepared with fish oil in this manner has very good adhesive properties. One sample of the paste of arsenate of lead and fish oil was analyzed by the Bureau of Chemistry and Soils and showed only 0.18 per cent of water-soluble arsenic, based on the quantity of arsenate of lead present in the mixture. This seems to indicate that little or no arsenic is made water-soluble in this process.

Similar mixtures of fish oil with barium fluosilicate, potassium fluosilicate, and cryolite have also been successfully prepared, although these materials make a somewhat flocculent mixture, and are somewhat difficult to pump. The addition of a casein-and-lime spreader, ½ ounce for each pound of the insecticide, appears to result in a smoother paste.

Before measuring out these paste materials for use in the spray tank, they should be vigorously and thoroughly stirred, since the solid matter tends to settle on standing.

B. A. PORTER and R. F. SAZAMA

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1928

The editors will thankfully receive news matter and other items likely to be of interest to our readers Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

Separates or reprints, if ordered, when the manuscript is forwarded, will be supplied to authors at the rates given below. Note that the number of pages in a reprint may be affected somewhat by the make-up, and that part of a page is charged as a full page. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

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Experience in field work in both Economic Entomology and Plant Pathology has demonstrated that no one spray, spray combination or general treatment is equally adapted to all situations. In the earlier days an insect was controlled, if it succumbed to spraying, with one or another of a few standard insecticides. To-day we are finding that plant tolerance and insect resistance are very important factors and as a consequence, research agencies are spending large sums in the search for more efficient or safer combinations for the control of various insects and plant diseases. This is reflected also in the market for insecticides and fungicides with its numerous combinations, many of great merit when properly used. There is no question but that a well-equipped chemical manufacturing company can produce a more reliable product than the private individual, especially when the latter, as is usually the case, lacks technical knowledge and is therefore compelled to follow directions which all too often may be inaccurately stated or misunderstood. There are, unfortunately, some commercial compounds where charges are disproportionate to the actual value of the materials and the cost of their combination under expert direction. This phase of the problem can not be entirely avoided, though it should be easy for most consumers to secure insecticides and fungicides through reliable agencies and thus minimize the possibilities of purchasing costly or inefficient materials. The search for better insecticides and fungicides to meet special conditions can hardly be developed to too great an extent and its vigorous prosecution means extremely valuable additions to the materials which may be used in the control of both insect pests and fungus diseases.

Obituary

J. RITZEMA BOS

Dr. J. Ritzema Bos, of Holland, who was elected a foreign member of the American Association of Economic Entomologists at the sixth annual meeting held in Brooklyn in August, 1894, died at Wageningen, Holland, on the night of April 6–7, following a surgical operation. He was taken ill several weeks previously and removed at once to the hospital for immediate operation.

Ritzema Bos led a life of usefulness, and achieved a very high standing among the authorities on agricultural zoology and plant pathology of the world. He was born July 27, 1850, at Groningen, where he took a five-year course in agriculture and later studied at the university. He gained his doctor's degree in 1874. He was first instructor of zoology in the Agricultural College of Groningen and later in the Royal Agricultural College. In 1876 he was made Instructor in Zoology at the Government Agricultural School established at Wageningen. In 1895 he was made Director of the Phytopathologic Willie Commelin Scholten Laboratory founded in Amsterdam, and was made Professor of Plant Diseases at the University of Amsterdam. In 1899 a government phytopathological service was established for Holland, largely through his efforts, and he was made its head. In 1906 an Institute for Phytopathology was formed in the Royal University for Agriculture, Horticulture and Forestry at Wageningen, and Ritzema Bos was made Director. This institution was replaced by the Agricultural College in 1918. He reached his seventieth year in 1920, and retired, and the agricultural and horticultural world of Holland gave him a great celebration.

He was the author of many publications, but is probably best known by his "Agricultural Zoology" and his "Textbook of Zoology." Further, he wrote a work in German entitled "Zoology for Agriculturists" which passed through six editions and was republished in England. He also wrote a large volume on "Animal Foes and Friends." He wrote extensively on eelworms, and was considered an authority on this group. He was considered the father of phytopathology (within the European understanding of this word) in north Europe. He was a very lovable man and gained the respect and friendship not only of his scientific colleagues but of the agricultural public in Holland. His former student and successor, Dr. T. A. Schoevers, tells an interesting anecdote about him. He had ridden with him to a farm at Zuyden van Nijmegen. The driver was resting in a small café while Ritzema Bos and Schoevers were having refreshments. The driver was overheard to confide to the proprietor of the café, "I have just had the most learned man in the world there in my buggy; that is the old perfester from Wageningen."

Ritzema Bos had visited America twice—the first time in 1898, when he was charged by the Netherlands government to investigate the San José scale in the United States. The last time was in 1921, when he was sent over by his government to discuss matters of plant quarantine with the people at the Department of Agriculture.

He attended many international conferences, and was well known all over Europe. I well remember the applause with which he was greeted when he entered the International Conference of Entomology and Phytopathology at Wageningen in the summer of 1923. We were very warm friends, and it is a cherished thought that the last thing written by him was an article about my seventieth birthday, which was published, the week after his death, in a Netherlands scientific journal edited by Doctor Schoevers.

L. O. HOWARD

Reviews

Leaf Mining Insects by JAMES G. NEEDHAM, STUART W. FROST and BEATRICE H. TOTHILL, pages i-viii, 1-351, 91 text figures and 3 plates. The Williams & Wilkins Company, Baltimore, 1928.

The leaf miners constitute a very interesting though not a natural group and for the most part have remained comparatively unknown because of the large number of species possessing this habit and also on account of the difficulty of rearing the adults and identifying the insects. We have in this volume a comprehensive digest of the available information concerning American species with illuminating references to the European fauna. The authors have succeeded admirably in providing an untechnical introduction to the study of leaf mining insects and in addition they have given under a systematic grouping accounts of the natural history of representatives of the different families containing leaf miners. There are numerous details which will be useful to the working ecologist. The third part of the volume is composed of lists of the leaf miners, of their food plants and of the technical papers treating of leaf miners. It is a source of regret to the reviewer that presumably space limitations made it impossible to more than list many species with references to their food plants. Many of the illustrations are original and add much to the values of the book.

The authors have rendered a very material service in bringing within the confines of one volume a digest of this widely scattered literature. It is really the history of the adaptability of various insects to special conditions and one finds among these insects numerous cases of parallel development, a phenomenon by no means restricted to the leaf miners. The list of leaf miners and of their food plants will prove especially useful to the nature student and also to the economic entomologists who are so frequently called upon to identify these insects from specimens of their work. The student of evolution and of response to environment will find much suggestive in this volume.

E. P. FELT

Current Notes

Mr. H. G. Butler, Assistant in Entomology at the Indiana Station, was appointed Assistant Entomologist at the Delaware Station, beginning April 1.

An intensive study of an outbreak of the maple leaf cutter is being made near Ottawa under the direction of Mr. J. J. de Gryse.

The Museum of Comparative Zoology at Cambridge has acquired the large private collection of Diptera amassed during the past thirty years by Mr. C. W. Johnson.

Messrs. L. H. Worthley, R. S. Clifton, H. N. Bartley, C. H. Hadley, C. W. Stockwell, and J. G. Sanders were recent visitors at the Connecticut Agricultural Experiment Station, New Haven, Conn.

According to *Science*, Dr. Carlos E. Porter of Santiago, Chili, Editor of the Rivista Chilena di Historia Naturale, has been elected president of the Entomological Society of Spain.

Mr. C. H. Griffith, of the Twin Falls, Idaho, sugar-beet leafhopper laboratory of the Bureau of Entomology, established a temporary summer substation at Corvallis, Oregon, on May 3.

Dr. J. C. Hamlin reported at the Salt Lake City Laboratory of the Bureau of Entomology on June 21, where he will assist Mr. G. I. Reeves on the alfalfa weevil project.

Mr. R. O. Malcomson, postgraduate student from the University of Illinois, spent his Easter vacation at the U. S. National Museum working up his collection of Mallophaga from Illinois birds.

Mr. W. A. Stevenson of the Tallulah laboratory of the Bureau of Entomology has returned to Arizona to continue studies on the Thurberia weevil in cultivated cotton in the Santa Cruz Valley.

According to *Science*, Mr. L. E. S. Eastham, lecturer in advanced and economic entomology at the University of Cambridge, has been appointed to represent the University at the International Congress of Entomology.

Mr. J. C. Elenore has established permanent headquarters at the Garden Grove, California, substation of the Alhambra laboratory of the Bureau of Entomology, to continue studies on the pepper weevil.

Mr. A. J. Chapman, Bureau of Entomology, who for the past two years has been in Arizona engaged in scouting and other investigations of the Thurberia weevil, has returned to Tallulah, Louisiana

Messrs. W. J. Brown, G. H. Fisk, and J. A. Adams left Ottawa on June 11 for the Knowlton district, Quebec, where they will conduct faunal studies and collect insects for the National Collection.

Mr. A. R. Graham was recently appointed assistant entomologist in the Entomological Branch, Ottawa, Canada. He is studying forest insect parasites at the Chatham laboratory under the direction of Mr. A. B. Baird.

Mr. H.S. Barber, U. S. National Museum, went to Boston in April and spent two days comparing specimens of Coleoptera with types of Le Conte species in the Museum of Comparative Zoology.

Mr. F. F. Bondy, of the Tallulah laboratory, has been placed in charge of the cooperative work of the Bureau of Entomology and State Experiment Station, recently established in South Carolina, with headquarters at Florence.

Mr. L. Chester Marston, Jr., who graduated at Amherst, specializing in entomology under Dr. H. T. Fernald, has been selected for the Teaching Fellowship in Entomology at the University of Tennessee for the scholastic year of 1928–1929.

Airplane dusting to control the alfalfa weevil is being carried on by the University of Nevada and the United States Bureau of Entomology, according to Mr. George G. Schweis, Field Entomologist of the Nevada State Quarantine Office.

Mr. Ralph Hopping reports that the British Columbia Forestry Branch is conducting bark beetle control operations at Lorna, under the direction of the Entomological Branch, and Mr. R. Rendell is assisting in this work.

Among the recent visitors at the Japanese Beetle Laboratory, Moorestown, New Jersey, are Arthur Gibson, Dominion Entomologist, Ottawa, Canada; Drs. C. C. McDonnell and E. Wallace, Washington, D. C.; F. D. Bailey, Corvallis, Oregon; Mr. Alejandro de Mesa, Manila, P. I.

According to *Science*, Dr. Claude Fuller, formerly chief entomologist of the Union of South Africa, has left Pretoria for Lourenco Marques, where he will assume the duties of chief entomologist to the government of Mozambique.

Recent visitors at the Gipsy Moth Parasite Laboratory, Melrose Highlands, Mass., are as follows: H. L. McIntyre, Albany, N. Y.; A. B. Baird, Chatham, Ont., W. B. Cartwright, Sacramento, Calif.; F. P. Washburn, Augusta, Maine; Professor J. A. Manter and several students from Storrs, Conn.

At the recent Commencement of the University of Pittsburgh, the honorary degree of L. H. D. was conferred upon Dr. W. J. Holland, who has been a trustee of the University for forty years, during ten of which he was its chancellor.

At the June Commencement of Ohio State University, the degree of doctor of philosophy was conferred upon Mr. Louis A. Stearns, Assistant Entomologist of the Ohio Agricultural Experiment Station in charge of the Oriental Fruit Moth Laboratory at Ironton, Ohio.

At the 38th annual meeting of the Ohio Academy of Science, held at Cincinnati, April 6 and 7, Professor James S. Hine was elected president, Miss Annette F. Braun, vice-president for Zoology, and Professor Raymond C. Osburn a member of the Executive Committee.

Dr. Herbert Osborn, Research Professor, Ohio State University, by vote of the Fellows of the Entomological Society of America, has been elected an honorary fellow of the Society. Other honorary fellows are C. J. S. Bethune, J. H. Comstock, S. A. Forbes, E. A. Schwarz, and L. O. Howard.

At the invitation of Professor R. W. Harned, T. E. Holloway of the Bureau of Entomology attended a meeting of the Biology Club at A. & M. College, Mississippi, on May 9, and gave a talk on the subject "Sugar cane and sugar-cane insects."

Temporary appointments in the Bureau of Entomology are as follows: E. C. Tatman, Sanford, Fla.; C. H. Smith, Richfield, Utah; G. R. McGinnis, Corvallis, Ore.; C. C. McCall, Clyde F. Rainwater, Tallulah, La.; Paul E. Kirker, Jr., Toppenish, Wash.; C. W. Getzendauer, Alhambra, Calif.; B. J. Landis, Geneva, N. Y.

Mr. E. R. de Ong, Consulting Entomologist, and formerly of the University of California, has received the doctor's degree from Stanford University. The thesis subject was "A Study of California petroleums and their derivatives with reference to their toxicity on insects and their effects on plants."

Dr. E. A. Chapin of the U. S. National Museum left Washington on April 19 for a ten days' trip to Cincinnati and Chicago, where he visited Messrs. Charles Dury, A. B. Wolcott, and Dr. F. J. Psota for the purpose of studying types of beetles belonging to the family Cleridae.

Of the eight thousand Ascogaster parasites of the codling moth collected at Yakima in 1927 by the Bureau of Entomology, over four thousand have been distributed to other States, two lots each having been sent to Colorado and California, and one each to Oregon, New Mexico, and Arizona.

Dr. M. T. Smulyan of the Gipsy Moth Laboratory, arrived in Washington on April 13, and spent a month studying chalcids of the family Perilampidae in the Museum collection. At present Dr. Smulyan is working on a revision of the genus Perilampus in North America.

Mr. F. W. Pettey, Senior Entomologist of the Union of South Africa, is visiting the United States on behalf of the South African Government to study the work of agricultural experiment stations, and will represent South Africa at the International Congress of Entomology at Ithaca, N. Y. in August.

Mr. Herbert T. Osborn, for many years connected with the Hawaiian Sugar Planters Experiment Station and later with the United Sugars Company of Los Mochis, Mexico, has accepted a position as entomologist to a group of sugar companies in Porto Rico and is located at Central Aguirre, Porto Rico.

Mr. George S. Langford, Deputy Entomologist under Professor Gillette of Colorado and during the past year a graduate student in entomology at Ohio State University, has accepted a fellowship with the Crop Protection Institute and is engaged upon a research problem at the Ohio Experiment Station at Wooster.

Dr. Ivar Trägardh, Forest Entomologist, Stockholm, Sweden, arrived in Washington, D. C., the last week in May, and after conferring with entomologists in the Bureau of Entomology, will visit many field stations and laboratories, especially those of the Division of Forest Insects in the western and southern states.

Miss Marjorie H. Ellis, of Iowa City, Iowa, has been appointed Senior Scientific Aid in the Division of Insects, U. S. National Museum. She will assist Mr. Gahan in the work on chalcids, and will do some indexing of literature. Miss Ellis has a B. A. degree from the University of Iowa.

Owing to the satisfactory results secured in the scouting and control operations against the gipsy moth at Henrysburg, Quebec, in recent years, there will be only one crew engaged on this work during the present season. Mr. S. H. Short is in charge of the work, which was commenced on May 21.

Mr. R. Glendenning of Agassiz, B. C., is supervising the earwig control campaign at Vancouver. The work of distributing poisoned bait throughout the city was commenced on May 9. Mr. Glendenning has liberated over 200 adults of *Digonochaeta setipennis*, earwig parasites, which were imported from the Imperial Bureau of Entomology and reared at Chatham.

Professor Bernard Trouvelot of the École Nationale d' Horticulture, Versailles, France, who is now a traveling fellow of the Rockefeller Foundation, is in the United States on a trip around the world and has visited many of the field stations of the Bureau of Entomology and other entomological agencies. He is especially interested in the biological control of insects.

The newly elected officers of the Entomological Club, University of Tennessee, Knoxville, are: President, J. N. Howell; Vice-president, W. N. Moser; Secretary-Treasurer, W. R. Fyke. The Entomological Club is an active organization made up primarily of the advanced students in the Department of Entomology and the members of the faculty in the Departments of Zoology and Entomology. Meetings are held each week.

Mr. F. H. Benjamin of the Bureau of Entomology collected specimens of *Anastrepha ludens* Loew in a sour orange which he picked from a tree in Matamoros, Tamaulipas, opposite Brownsville, Texas, on May 3. A thorough search during the growth of the crop of 1927–1928 failed to reveal any infestation in the fruit growing on the Texas side of the lower Rio Grande Valley.

Professor Roger C. Smith of the Kansas State Agricultural College, Manhattan, Kansas, is on leave of absence and will serve during the coming year as entomologist in the Service Technique, at Port au Prince, Haiti. Part of his time will be spent in teaching and the remainder in research in the Experiment Station under the direction of Dr. George F. Freeman, formerly of the Kansas Agricultural College.

Mr. S. M. Dohanian, Associate Entomologist, Bureau of Entomology, who has been connected with the gipsy moth and brown-tail moth parasite work for several years, was transferred to the European corn borer activity at Arlington, Mass., on April 16. At times Mr. Dohanian has suffered considerably because of the more or less constant exposure to the hairs of the gipsy moth and the brown-tail moth, and it is hoped that the new work will be less harmful to his health.

According to *Science*, Dr. R. J. Tillyard, entomologist of Australia, and assistant J. W. Evans, are in the United States and visited the Kansas Agricultural College, Manhattan, May 19 to 22. On May 20 a special field meeting of the Kansas Entomological Society was held at the fossil beds at Elmo, Kansas. On May 21, Dr. Tillyard addressed the zoological and entomological seminar on "The Relation of the study of fossil insects to insect evolution."

Dr. R. T. Cotton of the Bureau of Entomology attended the St. Louis meetings of the American Chemical Society, April 17 and 18, and took part in the symposium on insecticides. He read a paper by Cotton and Roark entitled "Ethylene Oxide as a fumigant," and discussed another paper by the same authors, "Tests of certain aliphatic compounds as fumigants." On his return trip Dr. Cotton visited several candy-manufacturing plants in Chicago.

Mr. Leslie H. Smith of Springfield, Ill., the ingenious and daring pilot who drove the plane in the hemlock spanworm airplane dusting operations in Wisconsin in 1926, was killed in Missouri the latter part of June. He was carrying films showing scenes at the Democratic National Convention from Houston, Texas, to St. Louis, and is believed to have been struck by lightning in the air over the Ozark Mountains in a storm during the night.

Mr. Harold A. Jaynes, formerly of the Japanese Beetle Laboratory of the Bureau of Entomology, has accepted a transfer to the Division of Cereal and Forage Insects. He will conduct investigations of parasites of the sugar-cane moth borer in South America, principally in Argentina, with the object of importing into the United States such species as may be promising. It is hoped that this program will result in some control of the sugar-cane moth borer in this country.

Dr. M. D. Leonard, who has been stationed at Cornell during the past year in connection with the corn borer campaign in New York State, has accepted a position to spend about four months in the principal apple-growing sections of the Northwest. He left Ithaca about July 1 on this work and will act as special investigator on codling moth control for the Tobacco By-Products and Chemical Corporation of Louisville, Kentucky. Dr. Leonard's address until further notice will be care of Professor C. R. Crosby, College of Agriculture, Ithaca, N. Y.

The following entomologists have recently visited the Division of Insects, U. S. National Museum, for the study of specimens or to consult with various specialists: Dr. W. A. Riley, University of Minnesota; Dr. Grace H. Griswold, Cornell University; Dr. E. D. Ball, Sanford, Fla.; Dr. Herbert Osborn, Ohio State University; Professor Dayton Stoner and Dr. Carl J. Drake, Iowa State College; Dr. W. T. M. Forbes, Cornell University; Mr. S. E. Cassino, Salem, Mass.; Mr. Alan S. Nicolay, Upper Montclair, N. J.; Dr. Frank J. Psota, Chicago, Ill.; Dr. Edwyn P. Reed, Valparaiso, Chile; Dr. D. M. De Long, Ohio State University; Mr. C. A. Thomas, Pennsylvania State College, Dr. Ivar Trägardh, Stockholm, Sweden.

The conference of the North-Central States Entomologists was held in Rebstock Hall, Washington University, St. Louis, Mo., on March 1 to 3, and was favored by having in attendance more working entomologists than have been at any previous conference of entomologists of the North-Central States. The Bureaus of Entomology and Chemistry, and the States of Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio, and Wisconsin were represented. At the noon recess on March 1, all who were in attendance at that time motored to the U. S. Entomological Laboratory, 527 Ivanhoe Place, Webster Groves, Mo., where the investigation of corn billbugs is the special project.

Dr. J. M. Swaine, Entomological Branch, reports that airplane dusting experiments against the spruce budworm are now in progress in the vicinity of Westree, Ontario. This work is being conducted under the direction of the Division of Forest Insects with the co-operation of the Dominion Air Service, the Ontario Department of Lands and Forests and the Spanish River Pulp and Paper Company. Messrs. Swaine, M. B. Dunn, E. B. Watson, A. H. MacAndrews, H. S. Fleming, and Flying Officer Bath are taking part in the experiments. It is planned to conduct airplane dusting work against the hemlock looper in the Muskoka lake region, Ontario, later in the season with the co-operation of the Ontario Department of Lands and Forests.

The eleventh annual meeting of the Northwest Association of Horticulturists, Entomologists and Plant Pathologists was held at the University of British Columbia, Vancouver, British Columbia, and at Victoria, British Columbia, June 25 to 28, 1928. A number of papers were given on entomological subjects of interest to those working in the Pacific Northwest. The entomologists attending this meeting were: Leroy Childs and Jos. Wilcox, Oregon Experiment Station; Dr. R. L. Webster and

A. Spuler, Washington Experiment Station; W. Downes, E. Hearle, E. P. Venables, A. A. Dennys, G. R. Hopping, Ralph Hopping, Max Ruhman, R. Glendenning, R. Buckell, Entomological Branch, Department of Agriculture, Dominion of Canada; F. H. Shirck, K. E. Gibson, L. P. Rockwood, M. A. Yothers, E. J. Newcomer, U. S. Bureau of Entomology. The officers elected for 1929 are: Dr. C. W. Hungerford, president; W. Downes, vice-president; F. M. Harrington, secretary. The twelfth annual meeting will be held at Bozeman, Montana, June 24 to June 26, 1929.

Dr. Alvah Peterson of the Bureau of Entomology has been elected to a professorship in the Department of Zoology and Entomology of the Ohio State University, effective with the opening of the school year this fall. He will give particular attention to the development of instruction and research in the biological control of insect pests. With this addition to the entomological staff the Ohio State University will offer a new course especially intended to develop the possibilities in insect control by means of such biological factors as predaceous and parasitic insects and the entomophagus and bacterial diseases affecting insects. Dr. DeLong will continue his work in courses in insect control with emphasis on the chemical and mechanical factors. Dr. Kennedy's major attention will continue in morphology and ecology and Dr. Herbert Osborn as research professor will have charge of graduate research in his special fields connected with the taxonomy and biology of insects.

Apicultural Notes

Everett Oertel was granted the degree of doctor of philosophy for major work in apiculture at the recent commencement at Cornell University.

Recent visitors at the Bee Culture Laboratory included Professor A. G. Ruggles of the University of Minnesota, St. Paul, and Mr. J. C. Dods of Kansas City, Mo.

Professor George H. Rea has resigned as extension specialist in beekeeping at the New York State Agricultural College, Ithaca, N. Y., to engage in honey production and queen rearing at Reynoldsville.

The North Dakota Beekeepers Association held a summer meeting at Lisbon, N. D., on June 27. The principal speakers were Professors Francis Jager and J. W. Thompson of the University of Minnesota.

Mr. James I. Hambleton of the Bee Culture Laboratory of the Bureau of Entomology, gave an illustrated talk on the life and habits of the honeybee at the Washington Club, Washington, D. C., on May 29.

Mr. A. C. Gould, last year fellow in biology at Cornell University, has been appointed to take charge of the apiary inspection for New York under the Bureau of Plant Industry at Albany, effective June 1.

Dr. Carlton E. Burnside of the Bee Culture Laboratory of the Bureau of Entomology, went to Leesburg, Virginia, on May 19 to examine a number of apiaries where abnormal death of adult bees had been reported.

The East Tennessee Beekeepers Association held a session on May 16 at Knoxville. There was a full attendance and an interesting program. Two all-day field meetings have been arranged for during the coming summer, one near Chattanooga, the other near Johnson City.

Mr. J. E. Eckert of the Intermountain Bee Culture Field Station, Laramie, Wyoming, has just returned from a trip to Lander, Wyoming, and Fromberg, Montana, where the Station has established temporary experimental apiaries. He reports winter losses to be somewhat above the average.

Mr. W. L. Walling, State Apiary Inspector of Tennessee, has just returned from his first inspection trip over the State and reports that the bees have wintered well and are at this time strong and bringing in abundant nectar. Mr. Walling began his second inspection trip on May 28.

Mr. B. A. Slocum, who has been taking graduate work in apiculture during the past year at Cornell University, has been appointed extension specialist in apiculture for New York, effective June 1. Mr. Slocum was extension specialist in this field in Washington State College for over six years before coming to Cornell.

Dr. H. E. Barnard, President of the American Honey Institute, Indianapolis, Indiana, conferred with officials of the Departments of Agriculture and Commerce during the week of June 18 concerning the activities of his organization. The American Honey Institute, whose primary purpose is to increase the sale of honey through educational means, is financed by the Bee Industries Association of America, which s composed of the principal manufacturers of beekeepers' supplies, honey bottlers, etc.

Mr. Dwight K. Grady, Secretary of the Dried Fruit Association of California, exporters of honey, conferred with Mr. R. R. Pailthorp and Mr. H. J. Clay, of the Bureau of Agricultural Economics, and Mr. James I. Hambleton, of the Bee Culture Laboratory of the Bureau of Entomology, on May 19, to discuss certain proposed changes in the color divisions of the United States grades for honey. The general outcome of the conference was that changes in the present grades are not needed nor particularly desirable at this time.

Mr. Walter M. Scott, Service Director of the Munsell Color Company Inc., Baltimore, Maryland, visited the Bee Culture Laboratory on June 27 to confer with the members of the staff concerning the future manufacture of the Pfund honey grader, which has been taken over by this company. The Munsell Color Company is working on an attachment for the grader which will make it possible to determine the degree of cloudiness in honey without interfering with the color readings, and is also perfecting a standard daylight lamp to be used with the grader.

Mr. E. L. Sechrist of the Bee Culture Laboratory and Mr. R. S. Kifer of the Bureau of Agricultural Economics, who are now making a survey of the cost of honey production and methods of management in the intermountain States, report that the beekeepers in those states are giving them fine co-operation in securing data. Mr. D. H. Hillman, State Inspector of Apiaries for Utah, one of the co-operators, who was assisting in the cost of honey production study, recently fell while doing inspection work and was quite severely injured.

Mr. James I. Hambleton of the Bee Culture Laboratory spent the early part of the week of June 4 in Baton Rouge, Louisiana, completing final arrangements for the establishment of the bee-culture field station authorized by the last session of Congress. The station will be established in connection with the University of Louisiana, which has offered the Bureau of Entomology laboratory quarters, heat, light, janitor services, and also certain funds for the purchase of equipment. The work started shortly after the first of July, with Mr. W. J. Nolan, of the Washington office, temporarily in charge.

An effort is being made to modify the limits of the color grades for extracted honey recently established by the Department of Agriculture, as the result of investigations by the Bureaus of Entomology and Agricultural Economics. The name of the American Honey Producers League is being used in this effort to modify the grades, although the League has taken no action on the question. Beekeepers of New York State are especially active in opposing this change, since the finest clover honey under the proposed grades would be compelled to carry a name indicating inferiority. Beekeepers of other parts of the clover region and of other beekeeping regions are also opposing this movement, which had its origin with certain western honey buyers.

Mr. James I. Hambleton of the Bee Culture Laboratory of the Bureau of Entomology, was invited to be present at the oral examination on May 28 of Mr. Lloyd M. Bertholf for the degree of Doctor of Philosophy in zoology at the Johns Hopkins University. His major problem for his degree work has been the response of the honeybee to light. Mr. Bertholf has held a temporary appointment at the Bee Culture Laboratory during the last few summers. While at the University Mr. Hambleton conferred with Dr. A. H. Pfund concerning improvements in the Pfund honey grader, which was adopted in 1925 as the official color grader of the United States Department of Agriculture. Mr. Hambleton also conferred with Dr. Raymond Pearl in connection with the biometrical studies being made at the Bee Culture Laboratory.

The so-called corn sugar bills which were introduced in both houses of Congress in January were not called to hearings, largely because of the opposition of beekeepers of all parts of the country. The beekeepers prevented the passage of similar bills in the 69th Congress. The present bills would authorize the addition of dextrose (corn sugar) to any manufactured or prepared food without declaration of its presence on the label. Since the present Foods and Drugs Act has so greatly stimulated beekeeping in this country, beekeepers are opposed to any modification which will destroy this beneficial law. Other powerful organizations of producers and manufacturers of food are joining the beekeepers in the opposition. Arrangements have been made to have almost every organization of beekeepers in the country represented at Washington in the event that hearings are ever called.

On the Monday following the close of the Fourth International Congress of Entomology at Cornell University, August 20, the Empire State Federation of Beekeepers' Societies will hold its annual summer meeting and picnic at the home of Mr. E. L. Lane, Trumansburg, about twelve miles from Ithaca. The purpose of holding this meeting at this time and place is so that persons attending the Congress who are interested in apiculture may have an opportunity to meet prominent New York beekeepers. On the following day, Tuesday, visits will be made to a series of commercial apiaries in the region, and on Wednesday the Western New York Honey Producers' Association will hold its annual summer meeting, in the hope that the visiting specialists in apiculture may still remain in the State for that meeting. Traveling accommodations will be provided for those who can remain.

Miss Winifred S. Hull, a medical student of Johns Hopkins University, Miss Mary Louise Crossman, who has just received her master's degree at the University of Michigan, and Mr. Ralph K. Day, a graduate student of the California Institute of Technology, have been appointed temporary field assistants of the Bee Culture Laboratory of the Bureau of Entomology. Miss Hull is to assist in the diagnosis of bee diseases, and to examine samples of adult bees to determine whether the Isle of Wight disease is present in the United States. Miss Crossman was employed at the Bee Culture Laboratory last summer and has been reappointed to assist in making observations in conjunction with investigations dealing with bee behavior, particularly with factors which determine the longevity of adult bees. Mr. Day is to investigate changes brought about in the color of honey due to the effect of temperature, light, age, etc.

Horticultural Inspection Notes

Mr. C. P. Daley, Junior Plant Quarantine Inspector, U. S. D. A., was transferred from Brownsville to El Paso, Texas, July 9.

The federal European corn borer quarantine was amended, effective June 1, 1928, bringing the entire State of New York within the one-generation regulated area.

Mr. A. G. Webb, Inspector in Charge at Seattle, Washington, spent the month of June inspecting special permit material in the State of California.

The federal pink bollworm quarantine was amended, effective April 25, 1928, by adding nine entire counties and parts of two others to the regulated area of Texas.

Mr. H. L. Sanford, of the Washington office, Plant Quarantine and Control Administration, spent the first three weeks in June inspecting special permit material growing in the State of Wisconsin.

Mr. Horace S. Dean, formerly employed by the Federal Horticultural Board in Washington, D. C., was reinstated June 25, and assigned to Brownsville, Texas.

The federal Japanese beetle quarantine was amended June 15, 1928, making certain changes in the requirements governing the movement of farm products from the regulated area.

Mr. L. M. Scott and Mr. J. M. R. Adams, of the Washington office, Plant Quarantine and Control Administration spent the month of June inspecting special permit material in the States of Ohio, Indiana and Illinois.

Restrictions on the importation of peaches into most of Canada have been lifted although the importation of these fruits into the Province of British Columbia from certain States is still prohibited.

L. M. Gates, Chief Nursery Inspector of the State Department of Agriculture, Lincoln, Nebr., reports as recent visitors to his office, Mr. Grady of the California Spray Chemical Co., and Mr. E. L. Chambers, State Entomologist of Wisconsin.

Mr. Allison O. Plummer, a graduate of the University of Illinois and recently employed as a nursery inspector in the State of Illinois, was appointed Junior Plant Quarantine Inspector July 2, and assigned to duty at New York, N. Y.

Mr. William J. Douglass, a graduate of Clemson College, South Carolina, and recently employed under the Thurberia Weevil project, was appointed Junior Plant Quarantine Inspector July 2, and assigned to the port of Douglas, Ariz.

Mr. B. D. Van Buren, Chief of the Bureau of Plant Industry of the New York Department of Agriculture and Markets, was in Washington June 27 and 28 conferring with members of the Plant Quarantine and Control Administration regarding the Woodgate rust problem and the white pine blister rust quarantine.

Mr. J. C. Moser, formerly of the Federal Horticultural Board, employed for port inspection work in New York City, has accepted a position as nursery inspector for the State of Tennessee. Mr. Moser began his new work July 1 and will work out of the office of the State Entomologist, G. M. Bentley, Knoxville.

Recent circulars relating to restrictions on the importation of certain products have been issued by the Federal Horticultural Board as follows: HB-213—"Entry of Narcissus Bulbs for Propagation in the Fall of 1928;" HB-215—"Conditions Governing the Entry of European Chestnuts Shipping Season 1928–29," and HB-216—"Conditions Governing Entry of Bananas."

A revision of the federal narcissus bulb quarantine governing the interstate movement of these bulbs in the United States was issued April 9, 1928, and became effective May 15, 1928. The changes relate to the certification of bulbs forced in greenhouses, treatments required for bulb-fly infested plantings, and forms of shipping certificates.

Mr. George G. Schweis, Field Entomologist in the State Quarantine Office, Reno, Nev., reports that every bundle of nursery stock shipped into Nevada must now be inspected immediately prior to shipment into that State. Blanket certificates showing inspection of the plants some months previous are no longer acceptable. Nursery stock not accompanied by a certificate of inspection as indicated will be returned to the point of origin or destroyed.

On June 27, a public hearing was held to consider quarantining the State of New York on account of the Woodgate rust on Scotch pine. An outline of the life history, present distribution and economic importance of the disease was presented by Dr. H. H. York, Pathologist of the New York Conservation Commission, and collaborator of the Bureau of Plant Industry of the U. S. Department of Agriculture, who is in charge of experimental work on this disease at Woodgate, N. Y.

A public conference to consider the advisability of placing further restrictions on the importation of fruit and rose stocks or any classes of them was held in Room 43 of the New National Museum, Washington, D. C., June 27, at 10 a. m., under the chairmanship of Dr. C. L. Marlatt of the Federal Horticultural Board. There was a representative attendance of growers and users of fruit and rose stocks, of State quarantine and inspection officers and of departmental employees.

Edward Dickey, Chief of the Division of Horticulture of the Montana Department of Agriculture, Labor and Industry, reports that white pine blister rust control operations are being carried on in the vicinity of Haugen, Mont., where seedling white pine and spruce are propagated for reforestry plantings in western districts. The chemical process of eradication is employed.

Messrs. E. B. Boyd and B. T. Jones, of Chicago, are acting as publishers of a series of quarantine circulars used by about two hundred of the leading railroad and steamship companies of the United States. Quarantines relating to the movement of live stock and of horticultural and agricultural products, whether issued by the U. S. Department of Agriculture or by the various State officers are given in this series of circulars, new issues of which appear from time to time. Those parts of quarantines which apply to transportation companies are printed in full. State quarantine officers are requested to supply copies of all new regulations of this class to the firm named in order that the railroads concerned may be promptly informed.

On May 10, Mexico issued a quarantine prohibiting the importation into that country of banana plants and parts thereof from foreign countries. This is Exterior Quarantine No. 7 issued by the Secretaria de Agricultura y Fomento. Other quarantines relating to the citrus canker, the coffee bean borer, the pink bollworm, the potato wart disease, the potato tuber moth, the Mediterranean fruit fly, and seed and paddy rice, have been issued. The plant quarantine work of that country has been reorganized during the past year and Mr. E. Coppel Rivas has been placed in charge under the direction of Dr. Alfonso Dampf, Chief Entomologist of the Mexican Department of Agriculture.

An amendment to the Plant Quarantine Act passed Congress in April and was approved May 1, 1928, giving employees of the Department of Agriculture authority to "stop and without warrant to inspect, search and examine [any] person, vehicle, receptacle, boat, ship or vessel [moving into the United States or interestate with quarantined articles] and to seize, destroy or otherwise dispose of such nursery stock, plant, plant products or other articles, found to be moving or to have been moved in interstate commerce or to have been brought into the United States in violation of this Act or of such quarantine or order."

The third annual joint meeting of the Federal Horticultural Board and the National Plant Board was held June 26, at Washington, D. C. Those in attendance were: Dr. C. L. Marlatt, and Messrs. J. E. Graf, M. B. Waite, E. R. Sasscer, S. B. Fracker, and S. A. Rohwer of the staff of the Federal Horticultural Board, and Messrs. L. A. Strong, Wm. Newell, W. A. McCubbin, W. C. O'Kane, R. E. McDonald, A. G. Ruggles, Geo. A. Dean and M. L. Dean, members of the National Plant Board. The National Plant Board held additional sessions at the Harrington Hotel, Washington, D. C., on June 25, 26 and 27.

Under the Act making appropriations for the Department of Agriculture for the fiscal year ending June 30, 1929, and for other purposes, approved May 16, 1928, the functions of the Federal Horticultural Board beginning July 1, 1928, devolve upon and will be exercised by the Plant Quarantine and Control Administration. The field work connected with the control and prevention of spread of the gipsy and brown-tail moths, the European corn borer, the Japanese beetle and the Mexican fruit worm were at the same time transferred from the Bureau of Entomology to the latter Administration and the white pine blister rust quarantine operations were transferred from the Bureau of Plant Industry. Dr. C. L. Marlatt, Chief of the Bureau of Entomology, has been appointed Chief of the Plant Quarantine and Control Administration, and Mr. S. A. Rohwer has been made Assistant Chief.

The Federal Horticultural Board, on June 27, held a public conference for the purpose of considering the advisability of making certain modifications in the requirements governing the interstate movement of five-leafed pines and currant and gooseberry plants under the white pine blister rust quarantine. Among the proposals discussed were the desirability of permitting the wider movement of five-leafed pines from the generally infected areas of New York and the New England States into more lightly infected States when such pines have been raised from seed in a nursery surrounded by a Ribes-free zone; the discontinuance of environs inspection and federal permits for the movement of currant and gooseberry plants from the infected

States; and authorization of the movement of cultivated red and white and mountain current and cultivated gooseberry plants interstate from infected States when they have been dipped in lime sulphur solution of specified strength, maintain certain required conditions as to dormancy and defoliation, and are shipped during certain less hazardous periods of the year.

Two cases of general interest to quarantine officers were decided in the District Court of the United States for the District of Arizona in March, when the judge lifted an injunction against the Secretary of Agriculture affecting movement of cotton from that part of the Thurberia-weevil regulated territory known as the Postvale area. These cases have been pending since November 15, 1926. The court decided that "The Act of Congress having conferred upon the Secretary of Agriculture the power and duty to find facts and determine conditions upon which the operation of the statute depends, such findings and determination can not be judicially reviewed in the absence of a showing that he acted arbitrarily or unfairly, or that there was no evidence to support such finding and determination." The plaintiff's application (1) that the Secretary of Agriculture be enjoined from the enforcement of the quarantine regulations, and (2) that the Southern Pacific be enjoined from refusing to receive and ship his cotton and cottonseed without compliance with said quarantine order and the regulations thereunder with respect to fumigation and sterilization, were both denied, and judgment entered for the defendants—the Secretary of Agriculture and the railroad company.

On May 12, the California Department of Agriculture issued a revision of the State Oriental Fruit Moth Quarantine. Under the revision, any and all varieties and species including the flowering forms, of peach, nectarine, almond, apricot, plum, cherry, choke-cherry, quince, pear and apple trees or plants or parts thereof, including the fresh fruits, and all boxes, barrels, baskets or other used containers of these fruits, arriving in California from the States of New York, Connecticut, New Jersey, Pennsylvania, Kentucky, Maryland, Delaware, West Virginia, Virginia, Tennessee, North Carolina, South Carolina, Florida, Georgia, Alabama, Mississippi, Louisiana, Arkansas, Texas, Ohio and Indiana, and the District of Columbia, will be refused admittance into the State of California.

Notes on Medical Entomology

Mr. Eric Hearle was transferred to the laboratory at Kamloops, B. C. from Indian Head, Sask., early in May to investigate livestock insect pests in British Columbia.

Mr. J. L. Webb of the Bureau of Entomology, visited the Marine Barracks at Quantico, Va., on April 20, to make a preliminary survey of the situation there regarding house flies. Some co-operative control work against them is planned, to be carried out during the present season.

Dr. Alfred E. Cameron, Professor of Zoology and Entomology in the University of Saskatchewan, Canada, has been appointed Medical Entomologist in the University of Edinburgh, Scotland. Dr. Cameron left Saskatchewan at the end of July and will take over his new duties in succession to Dr. W. S. Patten on October 1.

During the last week of April, Messrs. G. H. Bradley and T. E. McNeel of the Mound, La., laboratory of the Bureau of Entomology, made a brief survey of the region around Charleston, Miss., where a severe outbreak of buffalo gnats occurred. About 100 horses and mules were found to have been killed in that vicinity by the gnats.

At the urgent request of farmers and ranchmen in the Coachella Valley, California, D. C. Parman of the Bureau of Entomology spent the greater part of April studying the gnats (Hippelates) in this valley and in the Imperial Valley. These gnats have assumed major importance because of the annoyance they cause man, and almost certainly serve as important carriers of various eye diseases, including trachoma. Since Dr. Herms and Professor Woodworth have been studying the breeding habits and other phases of the problem, Mr. Parman devoted his attention entirely to preliminary observations on the chemotropic responses of the insects and the development of a trap for the purpose of catching them. A trap was devised which caught millions of the gnats and attracted much attention. In connection with this trip, Mr. Parman studied the screw-worm situation at various points in the western parts of Texas and in New Mexico and Arizona.

TROY STUDIO - 1926

FOURTH INTERNATIONAL CONGRESS OF ENTOMOLOGY

Photograph Register, Plate 16

1. W. J. Brown
2. G. Stewart Walley
3. Sara L. Harris
4. Eva M. Tully
5. John H. Gerould
6. William G. Lebowitz
7. Dr. Max Poser
8. A. B. Wells
9. F. L. Gambrell
10. Rodney Cecil
11. Birely J. Landis
12. J. R. Parker
13. Yeshwantras P. Bhosale
14. H. C. Huckett
15. Theo H. Eaton, Jr.
16. W. J. Holland
17. M. Cameron
18. I. P. Kryger
19. W. H. Brittain
20. A. B. Baird
21. C. H. Popenoe
22. E. G. Smyth
23. N. F. Howard
24 R. E. Mackie
25. William Tyson
26. Fritz Stellwaag
27. H. Eidmann
28. C. L. Marlatt
29. A. Dampf
30. K. Baunacke
31. W. Knechtel
32. J. Samal
33. Rev. J. Assmuth
34. G. C. Crampton
35. E. H. Wheeler
36. E. F. Phillips, Jr.
37. H. W. Parshley
38. Glenn W. Herrick
39. Robert Matheson
40. Julian P. Scott
41. Myron Gordon
42. P. W. Claassen
43. H. M. Tietz
44. W. W. Alpatov
45. D. N. Kaschkaroff
46. M. E. Ryberg
47. D. J. Caffrey
48. L. H. Patch
49. Mrs. J. A. Munro
50. J. A. Munro
51. J. B. Corporaal
52. E. D. Ball
53. M. N. Rimsky-Karsakow
54. Herbert Osborn
55. Mrs. J. R. Parker
56. V. Bayonnet
57. A. d'Orchymont
58. L. d'Orchymont (Miss)
59. W. S. Blatchley
60. E. P. Felt
61. W. M. Wheeler
62. F. Silvestri
63. L. O. Howard
64. Karl Jordan
65. E. L. Bouvier
67. S. A. Forbes
68. A. G. **Böving**
69. N. A. Kemner
70. A. B. Martynov
71. G. Enderlein
72. Richard Bledowsky
73. Walter Roepke
74. Elizabeth Skwarra
75. R. Streda
76. Max Dingler
77 P. Tshorbadjiev
78. F. Rambousek
79. V. Nickolsky
80. A. B. Comstock
81. P. Vayssière
82. Mme. Regnier
83. R. Jeannel
84 R. Regnier
85. R. J. Tillyard
86. J. C. F. Fryer
87. A. D. Imms
88. L. E. S Eastham
89. G. Fox-Wilson
90. H. L. Dozier
91. R. S. Filman
92. F. L. Campbell
93. W. Rupdolfs
94. J. S. Boyce
95. Aug. Busck
96. John Glassford
97. P. I. Lathy
98. A. A. Granovsky
99. Mrs. A. A. Granovsky
100. I. L. Ressler
101. F. Z. Hartzell
102. Henry G. Good
103. Antoine Ball
104. E. Martini
105. William A. Riley
106. Marshall Hertig
107. G. Ceballos

108. D. D. de Torres
109. A. B. Gahan
110. James Waterston
111. Augusto Merchán
112. P. R. Rincones
113. J. Montano Novella
114. Carl Heinrich
115. Mrs. C. P. Alexander
116. C. P. Alexander
117. H. H. Richardson
118. Theodore H. Hubbell
119. Alberto Graf
120. Walther Horn
121. J. G. Sanders
122. Theodore Dobzhansky
123. I. N. Filipjev
124. H. A. Scullen
125. B. A. Slocum
126. Philip Luginbill
127. August I. Balzer
128. B. Trouvelot
129. J. Sainte Claire Deville
130. F. Heikertinger
131. Mrs. S. C. McIndoo
132. N. E. McIndoo
133. Mrs. N. E. McIndoo
134. Mrs. E. N. Cory
135. E. N. Cory
136. E. F. Phillips
137. Millard C. Van Duzee
138. C. H. Newman
139. W. P. Flint
140. M. P. Jones
141. D. J. Jackson
142. Norma Ford
143. K. C. Sullivan
144. George P. Engelhardt
145. A. B. Klots
146. P. H. Timberlake
147. J. Speed Rogers
148. Mrs. J. C. Pallister
149. J. C. Pallister
150. Anna Hartzell
151. Albert Hartzell
152. Jas. S. Hine
153. Raymond C. Osburn
154. V. A. Little
155. Auburn E. Brower
156. Paul N. Musgrave
157. Andrew R. Park, Jr.
158. George S. Langford
159. George B. Bisset
160. John Carroll
161. William P. Hayes
162. Mrs. William P. Hayes
163. B. B. Fulton
164. Royal N. Chapman
165. Josephine Burns Glasgow
166. Ivar Trägardh
167. Robert D. Glasgow
168. G. J. Spencer
169. Cornelius Betten
170. Edgar Nelson
171. Charles W. Leng
172. Mrs. J. R. de la Torre Bueno
173. J. R. de la Torre Bueno
174. John D. Sherman, Jr.
175. A. L. Strand
176. S. Marcovitch
177. O A. Johannsen
178. C. M. Packard
179. W. H. Larrimer
180. Clarence H. Kennedy
181. D. M. DeLong
182. C. W. Stiles
183. Unio Saalas
184. E. Marsden
185. Mrs. R. E. Snodgrass
186. R. E. Snodgrass
187. W. J. Baerg
188. Mrs. E. E. Hose
189. Charles Hose
190. Ralph S. Hosmer
191. Margr. Marsden
192. Mrs. S. B. Fracker
193. Doris M. Fracker
194. J. Chester Bradley
195. Mrs. Virgil N. Argo
196. Hilda Jordan
197. Ada Jordan
198. Walter Carter
199. G. F. Ferris
200. G. Talbot
201. Edwin C. Van Dyke
202. W. B. Herms
203. W. T. M. Forbes
204. Harold Morrison
205. Emily Morrison
206. T. E. Snyder
207. Mabel Colcord
208. Miss Lucy Howard
209. P. W. Mason
210. R. W. Leiby
211. F. C. Fletcher
212. Louise M. Russell
213. J. S. Stanford
214. M. A. Stewart
215. James E. Collins
216. A. Avinoff
217. L. B. Prout
218. J. S. Houser
219. Hugo Kahl

220. J. Harold Matteson
221. T. H. Parks
222. C. R. Neiswander
223. D. N. Borodin
224. Hugh Glasgow
225. W. J. Schoene
226. Percival J. Parrott
227. Robert L. King
228. J. J. Davis
229. T. B. Mitchell
230. Chris E. Olsen
231. F. E. Lutz
232. F. M. Brown
233. L. S. McLaine
234. K. M. King
235. Henry Bird
236. I. A. Parfentjev
237. Grace E. Glance
238. Edwardo Gridelli
239. George Salt
240. W. H. Tams
241. A. P. Sturtevant
242. Ethel L. Coon
243. Jas. I. Hambleton
244. P. P. Babiy
245. Mrs. L. A. H. Peters
246. Mrs. L. H. Weld
247. Mrs. H. L. Knight
248. Mrs. Leonard Haseman
249. J. G. Needham
250. Virgil N. Argo
251. F. W. Edwards
252. F. M. Edwards
253. K. Watanabe
254. S. Inomata
255. Vasco M. Tanner
256. John Gray
257. Frank E. Blaisdell, Sr.
258. R. C. Roark
259. G. M. Bentley
260. Iva Hawes
261. Mrs. T. E. Snyder
262. Katheryn Slingerland Buys
263. John L. Buys
264. Hugo Hartnack
265. E. C. Faust
266. E. J. Anderson
267. J. O. Pepper
268. N. D. Riley
269. H. L. Knight
270. T. H. Frison
271. S. H. Williams
272. Alfred Emerson
273. A. M. Nadler
274. L. L. Huber
275. C. O. Eddy
276. J. Douglas Hood
277. W. V. Balduf
278. Joseph Bequaert
279. William Wild
280. S. M. Dohanian
281. F. M. Root
282. B. P. Young
283. D. A. Wilbur
284. E. Melville Du Porte
285. C. Bolivar y Pieltain
286. Mary M. Glance
287. George C. Wheeler
288. K. von Rosen
289. Charles H. Ballou
290. Mrs. Charles H. Ballou
291. L. A. H. Peters
292. Mrs. C. R. Crosby
293. Mrs. Glenn W. Herrick
294. Mrs. C. O. Eddy
295. Mrs W. W. Yothers
296. Mrs. J M. Aldrich
297. Mrs. P. R. Needham
299. George C. Embody
300. Donald T. Ries
301. E. R. de Ong
302. Clarence E. Mickel
303 Mrs. C. E. Mickel
304. C. K. Sibley
305. S. W. Frost
306. Lewis H. Weld
307. T. E. Holloway
308 Mrs. R. C. Roark
309. E A. Back
310. F. Muir
311 Alfred Weed
312. Ed. M. Searls
313. A. D. Bourne
314 A. V. Mitchener
315. D. E. Fink
316. N. S. Fink
317. F. G. Holdaway
318. Don C. Mote
319. George A. Filinger
320. Arthur Gibson
321. W. E. Hinds
322. George I. Reeves
323. Stanley E. Flanders
324. R. G. Schmieder
325. C. R. Cutright
326. Alan Stone
327. A. L. Brody
328. George W. Walton
329. C. H. Curran
330. W. H. R. Werner
331. S. C. Jones
332. Henry N. Goddard

333. A. G. Ruggles
334. A. C. Baker
335. Leif R. Natvig
336. Mrs. Tragardh
337. Mathias Thomsen
338. William S. Marshall
339. Mrs. Philip P. Calvert
340. D. L. Van Dine
341. R. W. Harned
342. Mrs. A. B. Gahan
343. Mrs. W. E. Britton
344. Mrs. R. D. Harwood
345. J. A. B. Nolla
346. R. D. Harwood
347. Mrs. Myron Swenk
348. William Middleton
349. H. J. MacAloney
350. A. R. Shadle
351. J. A. Manter
352. H. C. Efflatoun
353. Sybil F. Graham
354. Lloyd M. Bertholf
355. Mrs. Martha Bertholf
356. S. B. Fracker
357. F. H. Benjamin
358. Mrs. L. G. Gentner
359. A. R. Prince
360. F. W. Poos
361. Wm. A. Hooker
362. J. A. Hyslop
363. W.W.Yothers
364. W. A. Fowler
364A. C. T. Vorhees
365. Ida L. Reveley
365A J. Swezey, Jr.
366. W. J. Willis
366A. O. H. Swezey
367. C. F. Adams
368. Ralph L. Parker
369. Chas. O. Dirks
370. Leonard Haseman
371. Myron H. Swenk
372. Geo. M. List
373. G. E. R. Hervey
374. W. E. Britton
375. A. P. Morse
376. E. H. Hinman
377. G. F. White
378. C. E. Burnside
379. F. M. Jones
380. P. P. Calvert
381. Mrs. E. F. Phillips
382. O. W. Richards
383. Ruth Oertel
384. E. Oertel
385. Nulo A. Vappula
386. Kai C. Henriksen
387. Geo. Rea
388. P. R. Needham
389. W. S. Hough
390. F. N. Spaeth
391. P. T. Barnes
392. Ralph D. Dickey
393. F. S. Blanton
394. A. L. Treadwell
395. Prof. M. W. Blackman
396. Dr. F. C. Craighead
397. Wm. T. Davis
398. Raymond L. Taylor
399. L. G. Gentner
400. A. L. Melander
401. Mrs. A. L. Melander
402. C. W. Johnson
403. H. L. Parten
404. R. R. Parker
405. Clarence O. Bare
406. Seymour Hadwen.
407. O. C. McBride
408. J. M. Aldrich
409. J. L. Horsfall
410. Ann Morgan
411. Miss Cattell
412. Jacques Cattell
413. A. E. Stene
414. J. McK. Cattell
415. W. E. Rumsey
416. William H. Gurney
417. C. S. Thompson
418. Carryl Parker Haskins
419. Mrs. Carryl P. Haskins
420. Curtis Benton
421. G. Maheux
422. E. J. Hambleton
423. George A. Dean
424. G. H. Lamson, Jr.
425. Leroy Childs
426. Harry S. Smith
427. Franklin W. Pettey
428. A. F. Burgess
429. J. S. Wade
430. Wm. J. Gerhard
431. R. M. Geist
432. C. A. Thomas
433. Henry Dietrich
434. Mrs. A. G. Baker
435. A. W. Baker
436. Herbert Ruckes
437. Mrs. Herbert Ruckes
438. H. J. Quayle
439. Vernon R. Haber
440. B. A. Porter
441. P. G. Mundinger

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THE FOURTH INTERNATIONAL CONGRESS OF ENTOMOLOGY

By W. E. BRITTON

The Fourth International Congress of Entomology held at Cornell University, Ithaca, New York, August 12-18, is an important milestone in the history and progress of Entomology. Those who attended will never forget it. All preceding Congresses have been held in Europe and those who have attended them consider this Congress one of the most successful thus far held. There were 38 nations represented by delegates, and 625 persons registered as being in attendance, of which 134 were from foreign countries.

Probably no American university is in a better position to stage such a gathering than Cornell. The beautiful setting of the campus, charming environs, magnificent physical equipment of the University, well-considered and well-executed plans, and courtesy and thoughtfulness of all members of the local committee, and the fine weather, combined to make the week one of unalloyed delight to the visitors.

It was fitting that this Congress should be held at Cornell, one of the first universities in the country to establish a department of Entomology, and the scene of Professor Comstock's labors for more than half a century. It was also fitting that Dr. L. O. Howard, the first or one of the first of Comstock's students to graduate from Cornell, should be President of the Congress, preside at the sessions and deliver the presidential address. Had Professor Comstock's health been spared so that he might have attended and taken part in the Congress, our cup would have been full indeed. All attending Entomologists were gratified that Mrs. Comstock attended the meetings and took an active part in entertaining the visitors.

As an American attending for the first time one of these International Congresses of Entomology, the writer was particularly impressed by two points:

(1) The recent increase in research in economic entomology in foreign countries, particularly in Europe,—

(2) The comparatively large number of foreign entomologists who speak English.

International meetings of this character where men in similar scientific work may meet and become acquainted, and exchange opinions and experiences,—are of the greatest benefit, not only to Entomology but to the whole world. Each may learn the viewpoints of the other men and all can then better understand each other, thus minimizing the danger of those petty frictions and misunderstandings which are all too often the beginnings of conflict between nations.

A very pleasant affair was the banquet Friday evening at which 350 were present. It was splendidly managed by Dr. Howard as toastmaster, who called upon the official delegates from the foreign countries, asking each to respond in his own language. At the close of the banquet, a well-deserved tribute was paid to Dr. Howard.

At the general session, August 16, a graceful and courteous honor was conferred upon Dr. W. J. Holland on his eightieth birthday by electing him to honorary membership of the Congress. Later in the session honorary membership was conferred upon Dr. S. A. Forbes, who is eighty-four.

There were many factors contributing to make this Congress a success. To Cornell University and the Geneva Experiment Station, and their departments of Entomology, we owe a debt of gratitude, and especially to those members of the local committee who labored so unceasingly and successfully for the comfort and entertainment of the visiting entomologists. Apparently no detail had been forgotten or overlooked.

On Wednesday, August 15, all meetings were held at the Agricultural Experiment Station at Geneva, an excursion having been arranged for the purpose. There were some 15 excursions, with still others for the women, provided for those who wished to see something of the University, the city of Ithaca and the natural beauty and other interesting features of the surrounding country. One of the most interesting of these was a visit to Taughannock Falls and a picnic supper followed by a talk about the Indians of New York State, illustrated by songs and dances by three of these Indians in gala dress.

The next Congress of Entomology will be held in Paris in 1932, and American Entomologists are already making plans to save up money so that they can go.

Foreign nations were represented by delegates in attendance as follows:

Argentina: A. C. Bollini, Mrs. A. C. Bollini.
Armenia: V. S. Dakessian.
Australia: W. C. Gurney, F. G. Holdaway, R. J. Tillyard.
Austria: F. Heikertinger.
Belgium: A. Ball, A. d'Orchymont, Miss L. d'Orchymont.
Bulgaria: P. Tschorbadjieff.
Canada: A. W. Baker, W. H. Brittain, W. J. Brown, H. G. Crawford, J. D. Detwiler, E. M. DuPorte, Norma Ford, W. A. Fowler, A. Gibson, S. Hadwen, E. H. Hinman, A. Kelsall, K. M. King, A. G. Lochhead, G. Maheux, L. S. McLaine, A. V. Mitchener, A. G. Prince, W. A. Ross, G. J. Spencer, C. S. Thompson, G. S. Walley.
Chili: A. Graf.
China: E. C. Faust, C. C. Wang.
Cuba: A. Marchàn, D. L. Van Dine.
Czechoslovakia: J. Samal, F. Rambousek.
Denmark: K. L. Henriksen, J. P. Kryger, M. Thomsen.
Egypt: H. C. Efflatoun, Bey.
England: M. Cameron, J. E. Collin, L. E. S. Eastham, F. W. Edwards, Mrs. F. M. Edwards, G. Fox-Wilson, J. C. F. Fryer, Chas. Hose, Mrs. Chas. Hose, A. D. Imms, Miss D. J. Jackson, K. Jordan, Miss Hildegard Jordan, Miss Ada Jordan, L. B. Prout, N. D. Riley, O. W. Richards, G. Talbot, W. K. Tams, J. Waterston.
Finland: U. Saalas, Mrs. A. L. Saalas, N. A. Vappula.
France: E. L. Bouvier, R. Jeannel, Percy Lathy, Robt. Regnier, Mme. E. Regnier, B. Trouvelot, P. Vayssière.
Germany: K. W. Baunacke, M. Dingler, H. A. Eidmann, G. Enderlein, W. Horn, E. Martini, M. Schwartz, Miss E. Skwarra, J. Sainte Claire Deville, F. Stellwaag, Baron K. von Rosen.
Greece: G. W. Herrick.
Guatemala: J. M. Novella.
Hawaii: F. A. Muir, E. P. Mumford, Mary H. Swezey, O. H. Sewzey.
Hungary: R. Streda.
India: Y. P. Bhosale.
Ireland: John Carroll
Italy: E. Gridelli, F. Silvestri.
Japan: S. Inomata, L. Watanabe.
Mexico: A. Dampf.
Netherlands: J. B. Corporaal, L. A. H. Peters, Mrs. L. A. H. Peters, W. Roepke.
New Zealand: E. Marsden.
Norway: L. R. Natvig.
Poland: R. Bledowski.
Porto Rico: S. T. Danforth, A. S. Muller, J. Nolla.
Rumania: W. Knechtel.
Russia: W. W. Alpatov, P. I. Adrianov, N. N. Bogdanoff-Katjkov, T. Dobzhansky, L. N. Filipjev, D. Kashkarov, A. B. Martinov, V. Nikolsky, I. A. Parfentjev, M. I. Rimsky-Korsakov, P. Zaitzev.
Scotland: G. B. Bisset.

South Africa: F. W. Pettey, Mrs. F. W. Pettey, S. F. Skaife.
Spain: C. Bolivar y Pieltain, G. Ceballos, J. Nonell y Comas, F. Silvella, D. D. de Torres.
Sweden: N. A. Kemner, I. Trägardh, Mrs. D. E. Trägardh.
Venezuela: P. R. Rincones

The meetings of the Congress consisted of a general session each day usually in the morning, and twelve divisions or sections, usually meeting in the afternoon and papers were presented at each. Altogether 160 papers, 12 symposia or forum discussions, and two demonstrations were given, grouped as follows:

	No. Papers	No. Forum Subjects	No. Demonstrations
General Sessions	19		
Nomenclature and bibliography	4	3	
Ecology	7		
Medical and Veterinary	13		
Systematic and Zoogeography	19	6	
Morphology, Physiology, Embryology and Genetics	14		
Apiculture	11	2	2
Forest Insects	15		
Economic Entomology			
Cereal and Forage insects	29		
Citrus Fruit insects	9	1	
Deciduous Fruit insects	6		
Cotton insects	9		
Insecticides and appliances	5		
Total	160	12	2

As several of the sections were in session at the same time it was impossible for any one person to hear all of the papers, or even all which interested him, but with the large number of papers presented, probably no better arrangement could have been made. Some of the papers might have been shorter or only a summary given, thus allowing more time for discussion, but on the whole, the meetings passed off smoothly and pleasantly.

The proceedings of this Congress will be published in Europe, but as some time may elapse before the volume appears, a glance over the titles included in this issue will give a fair idea of the scope and character of the papers presented.

A group picture of the Congress was taken on Tuesday, August 14, and is reproduced in this issue.

PROGRAM

Space prohibits printing the entire program. The titles and authors of the papers presented at the meetings are listed below, though not necessarily in the order given.

General Session

Addresses of Welcome: Deans W. A. Hammond and Albert R. Mann, Ithaca, N. Y.

Address of the President: Dr. L. O. Howard, Washington, D. C.

Le peuplement de l'Amerique de Nord par les Trechinae: Dr. René G. Jeannel, Paris, France.

Fauna of the Soil in Swedish forests: Dr. I. Trägardh, Stockholm, Sweden.

Problems of distribution and variation of North American fleas: Dr. Karl Jordan, Tring, England.

Saturnides Americains: Dr. E. L. Bouvier, Paris, France.

Seuchen und Klima, von Standpunkt des Entomologen: Dr. Erich Martini, Hamburg, Germany.

On the splitting influence of the increase of Entomological knowledge and the enigma of species: Dr. Walther Horn, Berlin-Dahlem, Germany.

The relation of taxonomy to other branches of Entomology: Dr. Filippo Silvestri, Portici, Italy.

A neotropical myrmecophyte (*Cordia alliodora*) and its tenants: Dr. W. M. Wheeler, Forest Hills, Mass.

Insect inhabitants of the upper air: Dr. E. P. Felt, Stamford, Conn.

The mutual relations of museums of science and taxonomic specialists: Dr. W. J. Holland, Pittsburgh, Pa.

Fresh-water living Hymenopterous parasites in Russia: Professor M. N. Rimsky-Korsakov, Leningrad, Russia.

Development of entomological science in Egypt: Dr. Hassan Efflatoun, Bey, Giza, Egypt.

Restrictions enforced by the United States on entry of foreign plants and plant products for the purpose of excluding new and dangerous pests: Dr. C. L. Marlatt, Washington, D. C.

The share of the Netherlands in the development of Entomology in past centuries: J. B. Corporaal, Amsterdam, Holland.

Das mimicryproblem und seine Schwesterprobleme: Dr. Franz Heikertinger, Vienna, Austria.

Biological control of noxious weeds: Dr. R. I. Tillyard, Canberra, F. C. T. Australia.

Insect Control of noxious weeds: Dr. A. D. Imms, Harpenden, England.

Adaptations which prevent or hinder inbreeding in insects: E. B. Poulton, Oxford, England (read by D. N. Riley).

Nomenclature and Bibliography

The future of zoological nomenclature: Charles W. Stiles, Washington, D. C.

A protest against the use of abbreviations in original descriptions: J. E. Collin, London, England.

Sur la designation des genotypes: René G. Jeannel, Paris, France.

Das Kontinuitätsprinzip in der Nomenclature: F. Heikertinger, Vienna, Austria.

FORUM DISCUSSIONS

The theory of nomenclature: Discussion leaders: F. Heikertinger, Vienna, Austria; C. H. Kennedy, Columbus, Ohio; F. Muir, Honolulu, H. T.; G. Talbot, Surrey, W. H. T. Tams, London, and Karl Jordan, Tring, England.

Family names: Discussion leaders: Günther Enderlein, Berlin, Germany; A. L. Melander, New York, N. Y.; G. F. Ferris, Palo Alto, Cal., F. Muir, Honolulu, H. T.; W. H. T. Tams, London, and Karl Jordan, Tring, England.

Other problems in nomenclature: Discussion leaders: L. B. Prout, London, England; Myron H. Swenk, Lincoln, Nebr.

ECOLOGY

The measurement of the effect of ecological factors: Royal N. Chapman, St. Paul, Minn.

(Title not given on program): Paul I. Adrianov, Moscow, Russia.

Notes on some cavernicolous Tomoceridae and Sminthuridae from Spain: F. Bonet, Madrid, Spain (read by Demetrio D. de Torres).

On the relation between the color of silk worms and the environment: Kanji Watanabe, Tokyo, Japan.

The insect fauna of thermal springs: Charles T. Brues, Forest Hills, Mass.

Communication between members of a termite colony: Alfred E. Emerson, Pittsburgh, Pa.

Morphological and ecological studies on Chrysopidae: Miss Cebeova, Prague. Czecho-Slovakia (Read by J. Šámal).

The Doryloxenus of Java and Wasmann's hypothesis on their host change: N. A. Kemmer, Stockholm, Sweden.

MEDICAL AND VETERINARY ENTOMOLOGY

Arthropods as intermediate hosts of Helminths: M. C. Hall, Washington, D. C.

Arthropods in the transmission of Tularaemia: Edward Francis, Washington, D. C.

Rocky Mountain spotted fever: R. R. Parker, Hamilton, Mont.

The insect carrier of *Onchocerca volvulus* in Liberia, Joseph Bequaert, Boston, Mass.

Some poisonous arthropods of North and Central America: W. J. Baerg, Fayetteville, Ark.

Environmental factors and mosquito breeding: Willem Rudolfs, New Brunswick, N.J.

Anopheline investigations in California (lantern): W. B. Herms, Berkeley, Cal.

Mosquitoes in China and their potential relationship to human diseases: E. C. Faust, Peking, China.

Beeinflussung der Farbe von Mücken und ihren Larven: E. Martini, Hamburg, Germany.

The cattle grub (Hypoderma) problem from an international point of view (lantern): F. C. Bishopp, Washington, D. C.

On the development of malaria parasites in the mosquito host (lantern): W. V. King, Mound, La.

The present status of our knowledge of the Nyssorhynchus group of tropical American anophelines: F. M. Root, Baltimore, Md.

Animal coloration and its relation to parasitic attack: Seymour Hadwen, Saskatoon, Saskatchewan, Canada.

SYSTEMATIC ENTOMOLOGY AND ZOOGEOGRAPHY

The regional museum and one of its problems: E. P. Van Duzee, San Francisco, Cal.

Observations sur quelques coccides: P. Vayssière, Paris, France.

Remarks on the Keys of genera of European chalcid flies: J. P. Kryger, Gentofte, Denmark.

Particulars of the morphology and the geographical distribution of American Neohydrophilus: Armand d'Orchymont, Brussels, Belgium.

The C. F. Baker collection of Malayan insects: R. A. Cushman, Washington, D. C.

The Permian fossil entomofauna of North Russia and its relation to the Kansan: Andreas B. Martynow, Leningrad, Russia.

The geographical distribution of insects in Russia: I. N. Filipjev, Leningrad, Russia.

The influence which geographical distribution has had in production of the insect fauna of North America: E. C. Van Dyke, Berkeley, Cal.

The origin of the Hawaiian odonate fauna and its evolution within the islands: Clarence H. Kennedy, Columbus, Ohio.

An account of a collecting trip to Patagonia and southern Chile: F. W. Edwards, London, England.

The future of insect taxonomy: Walther Horn, Berlin-Dahlem, Germany.

On the classification of beetles according to larval characters: A. G. Boving, Washington, D. C.

The significance of odonate larvae for general entomology: Philip P. Calvert, Philadelphia, Pa.

Evolution of the Odonata: R. J. Tillyard, Canberra, F. C. T., Australia.

A palearctic satyrid: species in the making. A. Avinoff, Pittsburgh, Pa.

The role of function in taxonomy, and its relationship to the genitalia in insects: F. Muir, Honolulu, H. T.

The preparation for description and preservation of minute Hymenoptera: James Waterston, London, England.

Notes on holarctic Anastatus, with special reference to the name of gipsy moth parasites: C. Bolivar y. Pieltain, Madrid, Spain.

FORUM DISCUSSIONS

Taxonomy and phylogenetic groups: Discussion leaders: K. L. Hendrickson, Copenhagen, Denmark; Philip P. Calvert, Philadelphia, Pa.; F. Muir, Honolulu, H. T.; E. Martini, Hamburg, Germany; G. F. Ferris, Palo Alto, Cal.; Karl Jordan, Tring, England.

Catalogs: Discussion leaders: Antoine J. Ball, Brussels, Belgium; H. M. Parshley, Northampton, Mass.; F. Muir, Honolulu, H. T.; Karl Jordan, Tring, G. Talbot, Surrey, England; E. T. Cresson Jr., Philadelphia. Pa.

Types: Discussion leaders: James Waterston, London, England; W. J. Holland, Pittsburgh, Pa.; F. Muir, Honolulu, H. T.; Karl Jordan, Tring; G. Talbot, Surrey, England; F. G. Rambousek, Prague, Czecho-Slovakia.

The need of an international institute of entomology: Discussion leaders: Walther Horn, Berlin-Dahlem, Germany; J. D. Hood, Rochester, N. Y.

Collections: Discussion leaders: René G. Jeannel, Paris, France; E. P. Van Duzee, San Francisco, Cal.

Determinations. Discussion leaders: J. B. Corporaal, Amsterdam, Holland; Harold Morrison, Washington, D. C.; F. Muir, Honolulu, H. T.; Karl Jordan, Tring, England.

MORPHOLOGY, PHYSIOLOGY, EMBRYOLOGY AND GENETICS

Some new anatomical observations bearing on the interrelationships of Arthropoda: R. E. Snodgrass, Washington, D. C.

Segmentation of the Arthropod head: K. L. Henriksen, Copenhagen, Denmark.

Der Einfluss der temperatur auf Eizahl und Eiablage der Lepidopteren: H. A. Eidmann, Munich, Germany.

Insect polyembryony: R. W. Leiby, Raleigh, N. C.

The postembryonic development of *Phaenoserphus viator*, a Proctotrypid parasite of the larva of *Pterostichus niger*; L. E. S. Eastham, Cambridge, England.

Periodic reversal of heart action in the silk worm moth and pupa: J. H. Gerould, Hanover, N. H.

Metabolism in insects: J. H. Bodine, Philadelphia, Pa.

Ueber den Laut-apparat der Flöhe: Gunther Enderlein, Berlin, Germany.

The problem of the origin of geographical variation in the Coccinellidae: Th. Dobzhansky, Leningrad, Russia.

A new method for making microscopic slides of aphids: Walter Roepke, Wageningen, Holland.

Bau und Funktion des Graber'schen Organs den Tabanidenlarven: K. W. Baunacke, Dresden, Germany.

On the morphology of the female genital organs of the insects belonging to the panorpoid complex: Alfons Dampf, San Jacinto, Mexico.

Sex-determination in Lecanium: Mathias Thomsen, Copenhagen, Denmark.

Genetics of the Tortricid moth, *Acalla comariana*: J. F. C. Fryer, Herts, England.

APICULTURE

Variations in honeybees from the theoretical and practical points of view: W. W. Alpatov, Moscow, Russia.

Reactions of light in honeybees: Lloyd M. Bertholf, Baltimore, Md.

Sugar metabolism in honeybee larvae: Ethel Ronzoni and George H. Bishop, St. Louis, Mo.

Brood-rearing cycle of the Cyprian honeybee: W. J. Nolan, Washington, D. C.

Effect of weather factors upon the flight activities of the honeybee: James I. Hambleton, Washington, D. C.

Studies on the Etiology of European foulbrood: A. G. Lochhead, Ottawa, Canada.

A septicemic condition of adult honeybees: Carlton E. Burnside, Washington, D. C.

The minimum number of spores of *Bacillus larvae* necessary to infect a colony of honeybees: Arnold P. Sturtevant, Laramie, Wyoming.

The employment of Caucasian bees in the fertilization of red clover: A. Skorikov, Leningrad, Russia (read by I. N. Filipjev).

The work of the Moscow apicultural experiment station: A. F. Gubin, Moscow, Russia.

Discussion of proposal made by Dr. Louis Bahr, Copenhagen, Denmark, regarding international cooperation in apiculture, with reading of a letter from him on the subject

Discussion of proposal to affiliate the Apis Club (international) with the International Congress of Entomology.

DEMONSTRATIONS

Demonstration of artificial insemination of queen bees; three demonstrations by Lloyd R. Watson, Alfred, N. Y.

FOREST INSECTS

Ueber die Anwendung der Linien-abschätzung bei der Frequenzbestimmung von Forstinsekten: Uunio Saalas, Helsingfors, Finland.

Termites modify building codes: T. E. Snyder, Washington, D. C.

Die forstliche Bedeutung der Ameisen: H. A. Eidmann, Munich, Germany.

The control of imported tree-defoliating insects: A. F. Burgess, Melrose Highlands, Mass.

The organization and activities of the Division of Forest Insects: F. C. Craighead, Washington, D. C.

The biology and injury of *Monochammus galloprovincialis* in the fir forests of the Volga: M. Rimsky-Korsakov, Leningrad, Russia.

Silvicultural practices in the control of forest insects: E. N. Munns, Washington, D.C.

Barkbeetle epidemics in relation to windfalls: J. M. Miller, Palo Alto, Cal.

The larch sawfly and forestry: S. A. Graham, Ann Arbor, Mich.

Some methods of analysing the fauna of a dying tree (lantern): Ivar Trägardh, Stockholm, Sweden.

The present status of the leopard moth (*Zeuzera pyrina*) in the United States: W. E. Britton, New Haven, Conn.

Acalla hastiana, the destroyer of willow trees in Czechoslovakia: Jaromir Sámal, Prague, Czechoslovakia.

Some factors influencing outbreaks of and control of shade-tree insects: William Middleton, Washington, D. C.

An inquiry concerning the natural history of the white pine weevil (*Pissodes strobi*): T. C. Barnes, Cambridge, Mass.

Preliminary observations on the pine tip moth on southern pine: Philip C. Wakeley, New Orleans, La.

CEREAL AND TRUCK CROP INSECTS

The problem of controlling underground insect pests: J. W. McColloch and W. P. Hayes, Manhattan, Kans.

The value of quantitative methods of investigation of field crop insects with special reference to work with wireworms and cutworms: K. M. King, Saskatoon, Saskatchewan, Canada.

Local conditions as influencing recommendations for the control of sugar cane insects: T. E. Holloway, New Orleans, La.

Methods of fighting locusts in the Russian Soviet Socialistic Federate Republic: I. A. Parfentiev, Moscow, Russia.

Parasites of the genus Diatraea: D. L. Van Dine, Central Baragua, Porto Rico.

The problem of biological control of insects in Hawaii: F. Muir, Honolulu, H. T.

Can we increase the usefulness of the egg parasite, *Trichogramma minutum?* W. E. Hinds, Baton Rouge, La.

Present status of certain insect pests under biological control in Hawaii: O. H. Sewzey, Honolulu, H. T.

Atmospheric evaporation in relation to Mexican bean beetle abundance: A field study: N. F. Howard, Columbus, Ohio.

The control of root-eating Scarabaeid grubs in Queensland canefields: Edmund Jarvis, Queensland, Australia.

Hessian fly control in the United States: C. M. Packard, West Lafayette, Ind.

The European corn borer, *Pyrausta nubilalis* Hubn.; its history and status as a problem in the United States: D. J. Caffrey, Arlington, Mass.

The European corn borer, *Pyrausta nubilalis* Hubn.; its history and status as a problem in Canada: H. G. Crawford, Ottawa, Canada.

Experimental studies on the effect of "Kambara" earth upon the double cocoon formation on the silk worm: S. Inomata, Tottori, Japan.

Pea aphid investigations: J. E. Dudley, Jr., Madison, Wis.

The use of hydrocyanic acid gas in the control of greenhouse insects: C. A. Weigel, Washington, D. C.

The control of flour mill and stored grain insects: George A. Dean, Manhattan Kans.

The alfalfa weevil: George I. Reeves, Salt Lake City, Utah.

(Title not given in program): N. N. Bogdanov-Katjkov, Leningrad, Russia.

Silk culture in China: Kanji Watanabe, Tokyo, Japan.

Locusts in Russia for the last ten years: I. N. Filipjev, Leningrad, Russia.

Die Schadlichen Insekten in Bulgarien und die angewandte Entomologie: P. Tschorbadjieff, Sofia, Bulgaria.

An ecological basis for forecasting outbreaks of a serious insect pest: *Eutettix tenellus*, Baker. Walter Carter, Twin Falls, Idaho.

Some effects of temperature and moisture upon the activities of grasshoppers and their relation to grasshopper abundance and control: J. R. Parker, Bozeman, Montana.

Present position of controlling insects injurious to agriculture in the Russian Soviet Socialistic Federate Republic: Paul I. Adrianoff, Moscow, Russia.

The preliminary destruction of injurious insects before sowing: Francis Rambousek, Prague, Czechoslovakia.

The present status of economic entomology in Spain: Demetrio D. de Torres, Madrid, Spain.

Field insects of European and Asiatic Russia, with special reference to insects introduced into America: D. N. Borodin, New York City.

CITRUS FRUIT INSECTS

The fumigation of citrus trees: H. J. Quayle, Riverside, Cal.

Oil sprays for citrus insects, their history, uses and present status: W. W. Yothers and O. C. McBride, Orlando, Fla.

Biological control of insect pests of citrus fruits: Harry S. Smith, Riverside, Cal.

Insect problems of the citrus industry of different countries: Filippo Silvestri, Portici, Italy, and W. N. Gurney, Queensland, New South Wales, Australia.

DECIDUOUS FRUIT INSECTS

Codling moth control and removal of lead arsenate from fruit in South Africa: F. W. Pettey, Pretoria, Union of South Africa.

The codling moth problem in America: B. A. Porter, Vincennes, Ind.

The status of present spray practices and prospects of improvement in control measures for the codling moth: E. J. Newcomer, Yakima, Wash. (read by A. L. Quaintance).

The problem of arsenical residues; the situation in different apple-growing areas and results of investigations relative to the production of apples to meet market requirements: LeRoy Childs, Hood River, Ore.

The problem of arsenical residues; Importance of spray deposits from the standpoint of public health: Harry A. Kuhn, Edgewater, Md.

The mass production of *Trichogramma minutum* Riley, and observations on the natural and artificial parasitism of the codling moth egg; Stanley E. Flanders, Saticoy, Cal.

COTTON INSECTS

Biological notes on the pink boll worm in Texas. F. A. Fenton, El Paso, Tex.

The pink boll worm situation in Australia: F. G. Holdaway, Adelaide, South Australia.

The pink boll worm in Haiti: G. N. Wolcott, Port-au-Prince, Haiti.

Cotton seed disinfection as a control for the pink boll worm: R. E. McDonald, Austin, Texas.

Cotton insect control problems in the United States: B. A. Coad, Tallulah, La.

Mississippi methods of enforcing quarantines against cotton pests: R. W. Harned, Agricultural College, Miss.

The development of a control program for the Mexican cotton boll weevil and some of its results: W. E. Hinds, Baton Rouge, La.

The cotton flea hopper: W. V. King, Mound, La.

The status of the cotton leaf worm (*Alabama argillacea* Hbn.) in the West Indies: H. A. Ballou, Trinidad, B. W. I.

INSECTICIDES AND APPLIANCES

Pear psylla control: W. A. Ross, Vineland, Ontario, Canada.

The composition and use of oil sprays: E. R. de Ong, Berkeley, Cal.

A quantitative method of estimating the relative toxicity of stomach-poison insecticides: F. Leslie Campbell, and R. S. Filmer, Washington, D. C.

New stomach poisons for insects: R. C. Roark, Washington, D. C.

Cold stream spraying machines (lantern): R. W. Leiby, Raleigh, N. C.

Proceedings of the 13th Annual Meeting of the Pacific Slope Branch, American Association of Economic Entomologists

The thirteenth annual meeting of the Pacific Slope Branch was held at Pomona College, Claremont, California, June 14 and 15, 1928. The total attendance of 115 was far in excess of that of any other meeting. The interest in the program was such that many times discussion had to be cut short. Among the exhibits was one prepared by H. M. Armitage, deputy horticultural commissioner of Los Angeles County, which consisted of one million ladybird beetles (Cryptolaemus) confined in capsules, 10 to a capsule, all ready for distribution in citrus orchards to combat mealybugs. Instead of the usual entomologists dinner, a joint one was held with the biologists.

The meetings concluded with an extremely interesting and informative address by E. O. Essig on the early development of entomology in California.

PART 1. BUSINESS PROCEEDINGS

The meeting was called to order at 9:45 A. M., by Chairman Woglum, who spoke of the rapid development of entomology in the West. The following members were present.

Basinger, A. J., Riverside, Calif.
Boyce, A. M., Riverside, Calif.
Campbell, Roy E., Alhambra, Calif.
Cole, F. R., Santa Cruz, Calif.
deOng, E. R., Berkeley, Calif.
Doane, R. W., Stanford University, Calif.
Dodds, C. T., Santa Paula, Calif.
Elmore, C. J., Garden Grove, Calif.
Essig, E. O., Berkeley, Calif.
Flanders, S. E., Saticoy, Calif.
Flebut, A. J., Berkeley, Calif.
Freeborn, S. B., Davis, Calif.
Gray, Geo. P., Monrovia, Calif.
Herms, W. B., Berkeley, Calif.
Jones, W. W., Berkeley, Calif.
Jones, Paul R., Los Angeles, Calif.
Kirkpatrick, A. F., Monrovia, Calif.
Knight, Hugh, Glendora, Calif.
Lane, M. C., Toppenish, Wash.
Larson, A. O., Modesto, Calif.
Lewis, H. C., Sacramento, Calif.
Lockwood, Stewart, Billings, Mont.
Morrill, A. W., Los Angeles, Calif.
Morris, E. L., Santa Ana, Calif.
Neuls, J. D., Whittier, Calif.
Penny, D. D., Ontario, Calif.
Quayle, H. J., Riverside, Calif.
Reed, W. D., Fresno, Calif.
Roesling, C. F., Covina, Calif.
Rounds, M. B., Los Angeles, Calif.
Ryan, H. J., Los Angeles, Calif.
Simmons, Perez, Fresno, Calif.
Smith, Harry S., Riverside, Calif.
Smith, Ralph H., Riverside, Calif.
Sweezey, O. H., Honolulu, H. T.
Timberlake, P. H., Riverside, Calif.
Thompson, B. G., Corvallis, Ore.
Woglum, R. S., Los Angeles, Calif.
Woodhams, Geo. E., Azusa, Calif.
York, C. H., Pomona, Calif.

Report of the Treasurer for 1928

Balance on hand June 22, 1927		$ 9.49
Interest received from the bank.		.56
Refund from main Association for 1927 expenses		19.31
Paid out		
Typing and multigraphing.	$ 5.75	
Miscellaneous postage and registry	1.85	
Stamped envelopes	4.92	
Affiliation fee, Pacific Division A. A. A. S	5.00	
Announcements and reply cards	6.48	
	$24.00	$29.36
Balance on hand June 14, 1928	$ 5.36	
	$29.36	

Chairman Woglum announced the committee appointments as follows: Nominating, E. H. Ehrhorn, E. W. Morrill, P. R. Jones; Resolutions, O. H. Swezey, H. S. Smith, A. O. Larson; Auditing, H. J. Ryan, A. O. Larson; Membership, S. B. Freeborn, S. E. Flanders; Affiliation, E. O. Essig, R. W. Doane.

Final Business Session

Chairman Woglum called for reports of committees. The auditing committee reported that the accounts of the treasurer had been examined and found correct. The membership committee presented the names of ten applicants, with the recommendation that they be forwarded to the main association to be accepted as associate members.

The resolution committee reported as follows:

Resolved, That we express our appreciation and thanks to the officials of Pomona College for the accommodations that have been extended to us, and for all courtesies which have contributed to the success of the meeting.

Resolved, That a vote of thanks be extended to our officers for the excellent program which they have arranged, and for the skill and courtesy with which they have conducted the meetings.

Whereas Dr. L. O. Howard for nearly forty years Chief of the Bureau of Entomology, has recently retired from that position, and whereas, because of his scientific attainments, his enthusiasm and his personality, he has done more than any other scientist to advance the development of economic entomology in this country and throughout the world, therefore be it resolved, that we of the Pacific Slope Branch extend to Dr. Howard our congratulations on his long term of service as Chief of the

Bureau of Entomology, and we hereby express to him our high regard and the hope that for many years we may continue to enjoy his leadership in our profession.

The nominating committee presented the following names: Chairman, O. H. Swezey; Vice-chairman, Stanley B. Freeborn; Secretary, Roy E. Campbell. By motion and vote, the reports of the committees were approved and accepted.

After some discussion as to a stricter time limit on papers, and methods of presenting them so as to provide more time for discussion, it was voted to appoint a committee to arrange a method of conducting the next meeting and the presentation of papers, the committee to have full power to act. Chairman Woglum then appointed H. J. Quayle, F. R. Cole, and S. B. Freeborn as members.

The meeting adjourned, to meet next year with the Pacific Division, A. A. A. S.

THE INTRODUCTION OF NEW INSECT ENEMIES OF THE CITROPHILUS MEALYBUG FROM AUSTRALIA

By HARRY S. SMITH and HAROLD COMPERE, *Citrus Experiment Station, University of California*

ABSTRACT

The citrophilus mealybug, ***P. gahani*** Green, has steadily spread in the citrus groves of California. The control measures are biological, the ladybird beetle, ***Cryptolaemus montrouzieri***, being propagated for this purpose. During the present season the 13 insectaries will produce over 40,000,000 beetles at a cost of approximately $125,000.00. An expedition was made to Australia to find its native home, which was successful. Six species of natural enemies were found at Sydney, and successfully brought to California. They are ***Tetracnemus*** n. sp., ***Coccophagus*** n. sp., ***Diplosis*** sp., ***Pullus*** sp., ***Diomus*** sp., and ***Chrysopa*** sp. These are being extensively propagated and colonized in the citrus groves. ***P. gahani*** was also found in New Zealand where it is evidently introduced.

The citrophilus mealybug, *Pseudococcus gahani* Green, was first observed to be a serious pest of citrus trees in 1913. It was then thought to be the common Baker mealybug, *P. maritimus* Ehrhorn, but later studies by Clausen[1] indicated that it was distinct from the known species which infest citrus, and he described it as a new species, *P. citrophilus*. Still later, Ferris pointed out that it was synonomous with *P. gahani*, a new species described by Green during the same year from specimens taken on Ribes in London. Soon after the outbreak at Upland it was found on citrus at Pasadena, and later was found rather commonly on ornamentals around San Francisco Bay.

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[1] Clausen, C. P.—Mealybugs of citrus trees—Bul. 258, Univ. of Calif., Agr. Exp. Sta., p. 30. 1915.

The spread of the insect at Upland gradually increased and at the same time isolated infestations began to appear in various parts of Riverside, Los Angeles, Orange, Santa Barbara and Ventura Counties, and recently in San Diego County, so that now all of the Southern California counties excepting Imperial are infested. The coastal infestations are much more severe than those occurring in the interior, indicating that the insect favors a cool climate. This is also evidenced by its behavior in northern California.

The distribution in the citrus groves of southern California has extended rapidly until at the present time there are approximately 50,000 acres infested. It does not seem unreasonable to believe that within a comparatively short time all the citrus acreage of southern California will become infested, for while every effort is being made by Horticultural Commissioners and the State Department of Agriculture to prevent this, the local infestations are so generally distributed that natural spread alone, which it is impossible to prevent, will soon fill the intervening spaces. The citrus industry is thus confronted with a rapidly growing problem.

Fortunately there was available, at the time this insect began to demonstrate conclusively its capabilities as a pest, a control method which has been quite as satisfactory as that used against the red and black scales. The propagation and colonization of large numbers of the Australian ladybird beetle, *Cryptolaemus montrouzieri*, originally developed as a control for the common mealybug, seems to be almost equally successful against this species, with the exception mentioned later.

To apply the biological method of control against the citrophilus mealybug requires the operation at the present time of thirteen insectaries or propagating plants, maintained by the counties, growers associations and individual ranchers. There is invested in buildings and equipment for this work approximately $150,000, and the cost of operation runs from $100,000 to $125,000 per year. During the present season the production will reach a total of over 40,000,000 beetles. The plants are being continually expanded as the mealybug infestation increases in extent, and ultimately probably more than twice the present equipment and operating funds will be required. Thus, while far more economical than spraying or fumigation, neither of which is satisfactory for the purpose, the cost of control of the citrophilus mealybug is an item of considerable interest to the growers and is bound to increase greatly.

While as stated previously the frequent colonization of large numbers of Cryptolaemus is giving satisfaction in general, there are occasionally conditions under which there is some loss in spite of this. A cold late spring, such as occurred in southern California in 1927, retards the activities of Cryptolaemus at a time when the young mealybugs are hatching in enormous numbers. Under such conditions the mealybug population becomes so great that there is more or less fruit drop, and sometimes such heavy infestations necessitate the picking of the mature fruit and throwing it onto the market at a time when prices are low. Such fruit, if it can be held on the trees late in the season, brings much greater returns to the grower, and while it happens only very rarely that there is an actual reduction of either quality or quantity of fruit where the biological method has been properly applied, the throwing of the fruit onto an unfavorable market has at times resulted in some loss. Just what this has amounted to it is impossible to estimate because it is greatly complicated by infestations of black scale and orange Tortrix.

Believing that the biological control work against the citrophilus mealybug might be rendered still more effective if additional enemies, particularly internal hymenopterous parasites, were available, it was decided in the spring of 1927 to make a determined effort to locate the country of origin of this pest. The citrophilus mealybug normally becomes comparatively scarce in the groves during the period from July on. During this season the mealybugs occur to a considerable extent as isolated individuals scattered over the tree and many of these are able to escape destruction by a predator such as Cryptolaemus. These mealybugs are not sufficiently abundant to do any harm, but they give rise to the heavy spring generation which is the one that is most likely to cause injury. It was thought that an active hymenopterous parasite, which should be most effective during this portion of the season, would be better adapted to the destruction of these isolated individuals than a predator such as Cryptolaemus, and that if an effective parasite of this kind could be found and established, it might serve to reduce very greatly the numbers of mealybugs which produce the spring hatch.

It has been obvious ever since Clausen discovered that the citrophilus mealybug was a new species, that it was of foreign origin. Until recently it had been recorded only from the British Isles in addition to the California records. Recently Ferris has recorded it from South Africa but he believes it to have been introduced there as it has been in California. The history and method of its dispersal in California has seemed to be a logical basis for the assumption that it originated in some country in the Pacific maintaining direct steamship communication with San Francisco. Consequently, our foreign collectors, while not searching especially for the citrophilus mealybug, have always been instructed to be on the lookout for it especially when working in the various countries of the Pacific. Clausen of course knew the species intimately and searched for it in China, Japan, the Philippines and Formosa. Silvestri was supplied with both dry and slide mounts, and covered the same territory and in addition Indo-China. Kuwana's intimate knowledge of the coccid forms of this part of the world, along with the failure of our collectors to locate it, made it seem improbable that it was a native of the orient. In addition, Ferris has been interested in the problem. He has accumulated one of the most comprehensive mealybug collections in existence, but he wrote in 1927 "As to what its native country may be, I can not even guess." It seemed reasonable to conclude, therefore, that the most likely place to find the insect was in Australia, New Zealand or some of the South Pacific Islands. Accordingly, in August 1927 the junior author departed for Australia.

Search in the botanical gardens of Sydney shortly after his arrival revealed the presence of *P. gahani* on Choysia and oleander, although it appeared to be very scarce. Later an occasional specimen was found on citrus. These insects were colonized on potato sprouts in the laboratory in order to provide host material for possible natural enemies. Further investigation brought out the fact that *P. gahani* is attacked in Australia by the following insect enemies: Internal hymenopterous parasites, *Coccophagus* n. sp. and *Tetracnemus* n. sp., Dipterous predator, *Diplosis* sp. Coccinellid predators, *Pullus* sp. and *Diomus* sp., Neuropterous predator, *Chrysopa* sp. All of these species were established on the mealybugs in the insectary and preparations were at once begun to transport them to California because of the fact that it became evident the slender supply of mealybugs would soon be wiped out. It was decided by the junior author to return *via* N. Zealand as it was known that mealybugs were abundant there and additional food for use enroute might thus be secured. The Government Entomologist at Wellington, Dr. David Miller, was communicated with in regard to the plan and he very kindly met the boat and made it possible to secure ample supplies of mealybugs for use enroute. It was interesting to find, as had been suspected, that the citrophilus mealybug occurs commonly in New Zealand, where it has unquestionably been introduced from Australia. It is a serious pest of deciduous fruits in that country.

The junior author arrived at Riverside, California, in March, all six species of parasites and predators having made the journey successfully. All of them have propagated satisfactorily in our insectaries and all have been colonized in the citrus orchards of Southern California. In addition most of the local insectaries have been supplied with breeding stock and some are now colonizing insects of their own production.

All of these species breed readily in confinement. The two internal parasites, Coccophagus and Tetracnemus, are very prolific and develop on practically all stages of the mealybug, and since they go through a generation in approximately 30 days, they should increase rapidly in the field. Just what resistance they will meet from native secondaries the future must develop, but none of our local primaries on mealybugs so far as we know are seriously checked by this factor. *Leptomastidea abnormis*, introduced from Sicily on *P. citri*, is attacked by *Thysanus* sp. but it never has become abundant enough to be of any practical importance as a check to the parasite. There are other secondaries on mealybugs in California which it is conceivable may in time attack these species, but we do not anticipate any serious difficulty in this direction. These two species seem to be very promising, since there are no internal parasites[2] of *P. gahani* in California and hence they will meet with no competition.

The dipterous predator, Diplosis, is a most interesting insect. It appears to be the most prolific of all, going through a generation in 12 days, and it increases in the cages with extreme rapidity. It seems to have no counterpart in the mealybug environment in this state, although in most other countries species of Diplosis are perhaps the most effective of mealybug enemies. Whether this is due to the unsuitability of the environment here or simply to the fact that they have never been introduced, even accidentally, is unknown. It promises to be very effective, if one can judge by its behavior in the insectary.

Pullus and Diomus, the two coccinellids, are slow breeders in the insectary, but their possible value lies in their habit of seeking the mealybugs in their hiding places under leaves, beneath the bark, etc., in places where parasites and other enemies are unlikely to find them.

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[2] *Pseudaphycus angelicus* has been reared once or twice from this species, but apparently it is only accidental.

It appeared to the junior author that Pullus may be especially attracted to *P. gahani*, as he almost invariably found it associated with that species in Australia, and although he collected numerous lots of other species of mealybugs, in few cases did he find this ladybird in association with them.

Chrysopa is a large, voracious, extremely active predator, the larvae of which clothe themselves with the wax and skins of the mealybugs which they devour. This species, like most Chrysopas, is a rather general feeder, destroying not only mealybugs but other coccids and aphids as well. It is abundant in Australia in the citrus groves. It takes readily to domestication, and can be reared in great numbers in the insectary. In this way it differs markedly from our native Chrysopas which feed on mealybugs. The especial value of Chrysopas in connection with mealybug control lies in the fact that they are active during the winter when most of the other mealybug enemies are practically dormant.

PRESENT STATUS OF CERTAIN INSECT PESTS UNDER BIOLOGICAL CONTROL IN HAWAII

By O. H. SWEZEY, *Entomologist, Experiment Station of the Hawaiian Sugar Planters' Association, Honolulu, Hawaii*

(Illustrated with lantern slides)

ABSTRACT

In Hawaii the introduction of natural enemies for the biological control of insect pests has proven satisfactorily successful in a number of cases. The present status of some of these pests is herewith given. The cottony cushion scale is found occasionally in small colonies, but is not of any importance as a pest, The sugar cane leafhopper no longer produces significant interference with the growth of the cane. The sugar cane borer is satisfactorily controlled in the most of the sugar cane districts, but in some places and under certain circumstances is still causing many thousands of dollars losses annually. The spread of the cane rootgrub has been checked and it is not in the least injurious any more. Armyworms are well controlled, so that only occasional outbreaks occur in cane fields, and then of little importance. The grey sugar cane mealybug is sufficiently controlled. The avocado mealybug is 100% controlled, almost completely exterminated. The Mediterranean fruitfly is 55% controlled. The melonfly somewhat better than that. Bruchids in algaroba beans are pretty well controlled. Plant lice fairly well controlled. Some of the scale insects are well controlled, but others not sufficiently.

Perhaps it is generally known that in the Hawaiian Islands remarkable success has been attained in the control of insect pests by the introduction of their natural enemies from other countries. As in many other places, so in Hawaii the worst pests are not native insects, but introduced species that have gained admission in some way through the channels of commerce. We have had a number of very destructive ones in Hawaii. The work of the entomologists in searching for natural enemies in the homes of these pests and their introduction to Hawaii began in 1893 by the employment at that time of the late Albert Koebele for this purpose. As a matter of fact one very valuable ladybeetle had been introduced before that time by Mr. Koebele, namely: *Novius cardinalis* (Muls.) in 1890, after it had become established in California as an enemy to the cottony cushion scale (*Icerya purchasi* Mask.). This ladybeetle proved as successful in Hawaii as it had in California in controlling the cottony cushion scale. This pest was very severe on fruit trees and ornamental trees and shrubs before the establishment of the ladybeetle. It was soon brought under control, and for a long time now has not been of any importance as a pest. Its present status is that it maintains its existence, and small colonies are occasionally met with which are soon destroyed by the arrival of the ladybeetle. Serious injury is done only in cases of isolated, very small trees, as young seedlings becoming infested, or young nursery stock, in which cases the small plants may be badly injured by the cottony cushion scale before the ladybeetles increase sufficiently as to reduce the pest colony.

SUGAR CANE LEAFHOPPER, *Perkinsiella saccharicida* Kirk.: The most destructive pest in Hawaii has been the sugar cane leafhopper. It was most probably introduced from Australia in imported cane cuttings for planting more than 30 years ago. By 1902, it was attracting attention in all the sugar cane districts of the Islands and causing considerable alarm. By 1904 it was causing an estimated loss of $3,000,000 annually, and threatening the sugar industry with ruin. Parasite introduction began the previous year. The successfully introduced parasites were as follows:

Egg-parasites:	*Paranagrus optabilis* Perkins.	Queensland,	1904.
	" *perforator* Perkins.	"	1904.
	Anagrus frequens Perkins.	"	1904.
	Ootetrastichus beatus Perkins.	Fiji,	1905.
	" *formosanus* Timb.	Formosa,	1916.
Dryinidae:	*Haplogonatopus vitiensis* Perkins.	Fiji,	1906.
	Pseudogonatopus hospes Perkins.	China,	1907.

Egg-sucking bug: *Cyrtorhinus mundulus* (Bredd.) Queensland & Fiji, 1920.

Of the earlier introductions, the egg-parasites were the most effective and of them *Paranagrus optabilis* the best of all. With their establishment, together with the help of quite a number of native parasites and predators, the leafhopper pest was gradually reduced so that by 1917 in most plantations very little damage was done by leafhoppers. A few plantations were still suffering considerably. After the establishment in 1922 of the *Cyrtorhinus* bug which sucks the eggs, the pest was still further reduced, so that finally it was under complete control.

The present status of the leafhopper is that it is very scarce and hard to find in the most of the sugar cane area. In an occasional instance they become noticeable but not abundant enough to be injurious. Their enemies, especially the *Cyrtorhinus* bug soon appear and increase so as to reduce the pest again to scarcity. A great deal of work is being done in the propagating of seedling varieties, and occasionally a few among these seem more susceptible to leafhopper, or at any rate they may become more conspicuously populous with leafhoppers than the others. At times, too, the leafhoppers become more numerous in fields of cane that are affected with the "eyespot" disease.

At the present time, it is the usual condition of the cane to be free from the honeydew of the leafhopper; whereas, in the years when the leafhopper pest prevailed, the cane was always sticky with honeydew and the leaves covered by sooty mold which flourished in the honeydew. It was impossible to enter a cane field without at once becoming messed up with this honeydew and black mold. Now, one encounters no such difficulty, for the cane leaves are usually clean.

THE SUGAR CANE WEEVIL BORER, *Rhabdocnemis obscura* (Boisd.): This cane borer has for a long time been an important pest. It was known as a cane pest as long ago as in the '60's, and is thought to have been introduced from Tahiti with cane cuttings for planting at an earlier date. It became generally dispersed throughout the Islands and in some places wrought great havoc in the cane fields. Sometimes fields of cane would be half destroyed. Various practices were made use of to try to check it, but with little effect, and there was an annual loss that must have amounted into the millions. However, after the New Guinea Tachinid (*Ceromasia sphenophori* Vill.) was discovered, and introduced in 1910, there began to be a reduction in the number of borers, and a consequent reduction of the loss of cane by them. In one of the plantations that was most subject to losses by the borer, in three years the number of infested canes fell from 30 to 12.77 per cent, with a resultant increase of about .7 ton of sugar per acre, or about 1400 tons of sugar for the whole plantation annually, equivalent to a saving of more than \$100,000.00. On another one of the worst borer-infested plantations, in four years, due to the reduction of borer damage, the yield of sugar per acre increased by 2 tons, or a saving of nearly \$100,000.00 to the plantation. Conditions continued to improve until now, after 18 years, the loss by borer is negligible for the greater part of the sugar cane area. There still are borers on all of the plantations, but on those so situated as to be the least favorable to the borer, the parasite keeps them reduced to such scarcity as to be ignored. In other situations their numbers increase, even up to an infestation of 30 per cent of the canes. This does not mean a loss of 30 per cent, for many of the infested canes are not entirely destroyed but still are of some value for sugar. Usually, nowadays, these most severe borer infestations are where there is a great growth of cane of two years' growth, or more, and much of it decumbent and buried by the fallen dead cane leaves, so that the borers in these canes are where they cannot be reached by the parasites, hence, can increase in numbers unchecked and with a consequent increase in injury to the cane. So that, although, there is an enormous saving due to the work of the parasite in checking the borer, the latter still causes thousands of dollars losses to some of the plantations. The estimate last year on one of the plantations having the greatest borer damage was a loss of \$200,000.00. On the other hand, when examining the borer injury, or hunting for borers in most regions, the borers are nearly all found to be parasitized, fully demonstrating the value of the parasite in controlling the pest.

CANE ROOTGRUB, *Anomala orientalis* (Waterh.): This pest made its appearance in cane fields as recent as 1912. It spread from one locality until it was causing a loss of \$50,000.00 annually to two plantations partially infested by it, before its spread was checked by an introduced parasite, and it was reduced to harmless numbers. The parasite in this case was a digger wasp (*Scolia manilae* Ashm.) from the Philippines, which was introduced in 1916, and soon increased so rapidly, destroying the grubs and checking the spread of the pest, so that within two years the damage done by them had been reduced to insignificance. Now a specimen of either the grub or beetle is seldom found. Thus was checked a pest that otherwise would have become spread throughout the cane area on the island of Oahu, and no doubt eventually to the other Islands.

ARMYWORMS, *Cirphis unipuncta* (Haw.) AND *Spodoptera mauritia* (Boisd.): There have been outbreaks by these two common armyworms, usually annually for many years, especially in those sugar plantations situated adjacent to grasslands, or having fields infested with nutgrass which is the favorite food of *S. mauritia.* Parasites have been introduced at various times and from various places until now armyworms are so well controlled that outbreaks seldom occur on most of the Islands, and not so often or so extensive on the island of Hawaii where these outbreaks have been the most prevalent. This has been the case especially since the introduction from Mexico in 1923 and 1924 of *Euplectrus platyhypenae* Howard and *Archytas cirphis* Curran. Other valuable parasites working on armyworms here are: *Amblyteles koebelei* (Swezey), *Amblyteles purpuripennis* (Cress.),*Hyposoter exiguae* (Viereck), *Chaetogaedia monticola* (Bigot) and *Frontina archippivora* Will., all from California, and an egg-parasite, *Telenomus nawai* Ashm. from Japan.

GREY SUGAR CANE MEALYBUG, *Pseudococcus boninsis* (Kuwana): This mealybug is so completely controlled by *Pseudococcobius terryi* (Fullaway) as to be rarely met with. This parasite does not attack the pink sugar cane mealybug, *Trionymus sacchari* (Ckll.), and this mealybug is found generally prevalent in all cane fields though not rated as a serious pest. A number of ladybeetles that feed on mealybugs have been introduced, but they do not feed to any extent on the pink sugar cane mealybug.

AVOCADO MEALYBUG, *Pseudococcus nipae* (Mask.): Introduced ladybeetles fed on this mealybug to some extent but apparently exercised no control. Avocado trees always had the leaves badly covered by this mealybug. It also badly infested fig, mulberry, guava, coconut and some other trees as well. Finally the little parasite, *Pseudaphycus utilis* Timb.,was introduced from Mexico in 1922. It quickly became established and spread throughout Oahu, and was distributed to the other Islands where it spread similarly. In about two years the avocado mealybug was practically exterminated. The leaves of avocado now remain clean, as do also the leaves of the other trees mentioned that were formerly infested by *nipae.* No infestations are found on any of these trees. It has been a most remarkable case, both as to rapidity of spread of the introduced parasite, and the completeness of its work on the host insect.

COTTONY MEALYBUG, *Pseudococcus filamentosus* (Ckll.): A parasite was introduced for this mealybug in 1925, from Hongkong. It is *Anagyrus dactylopii* (Howard). It readily became established, and the mealybug has become scarce. Possibly it may become as well controlled as is *P. nipae.*

PLANT LICE: A number of the common plant lice have been troublesome in the past and quite a number of ladybeetles and other enemies have been introduced at various times. At present all of these working together seem to keep most plant lice from becoming serious. Often there may be an outbreak which appears serious for a time, but the ladybeetles and other aphis enemies soon find them and quickly check and eliminate the pest. Probably the plant lice are as well controlled in this way as in any other country. Seldom does anyone practice spraying or dusting for these outbreaks of plant lice.

MEDITERRANEAN FRUITFLY, *Ceratitis capitata* Wied.: This pest made its appearance in 1910 and soon became generally spread, severely attacking nearly all kinds of fruit of importance except banana, avocado (slightly), and pineapple. Of the common fruits perhaps the peach, mango and guava were the worst attacked, it being next to impossible to obtain a fruit of these free from maggots.

The following parasites have been introduced:

Opius humilis Silv. from Africa in 1913.
Diachasma tryoni Cam. from Australia in 1913.
" *fullawayi* Silv. from Africa in 1914.
Tetrastichus giffardianus Silv. from Africa in 1914.
Dirhinus giffardii Silv. from Africa in 1913.

Records that have been kept of the work of these parasites during the past few years, show that on the average about 55 per cent of the fruitfly maggots are destroyed by the parasites. In coffee cherries practically all maggots are parasitized, and in the case of mangoes, though the parasites do not reach many of the maggots in the fruits, yet the fact that many mangoes escape being infested indicates a considerable reduction of the fruitfly. The guava serves also as an index, for, whereas nearly all guavas on the bushes occurring wild in the valleys and hills were infested by fruitfly, at the present time a good proportion of them escape becoming infested.

MELONFLY, *Chaetodacus cucurbitae* (Coq.): This pest gained access to Hawaii about 1895, and soon put a stop to the successful growing of melons. It is said that before that time fine watermelons were grown in great abundance, and also canteloupes, but after the arrival of the melonfly from the Orient these were grown with great difficulty and mostly disappeared from the markets. All cucurbitaceous fruits became badly infested and tomatoes as well. The parasite, *Opius fletcheri* Silv., was introduced from India in 1916. It has done good work against the melonfly in the gardens as shown by the abundance of watermelons the past few years, some canteloupes also. The watermelons, too, are on the markets for a period of several months each summer. Another conspicuous indication that the melonfly is pretty well controlled is that perfect cucumbers are obtainable in abundance the year round in Honolulu, whereas, before the introduction of the parasite it was difficult to get good ones, they being mostly ill-shaped from having been infested by the melonfly maggots, yet survived sufficiently so that they were for sale by the vegetable pedlars. Tomatoes too are not nearly so badly infested any more.

Mesquite or Algaroba Bruchids: Several species of bruchids have become established in Hawaii of recent years. Among them the following four feed in the algaroba pods: *Bruchus prosopis* Lec. has been known for over 20 years; *Pachymerus gonagra* (Fab.) first known in 1908; *Bruchus sallaei* Sharp in 1918; *Bruchus amicus* Horn in 1923. These algaroba pods grow in quantity and are much used as stock food. With these 4 bruchids infesting them, their value was greatly diminished, especially if stored for any length of time. The following parasites have been introduced from Texas:

Egg-parasite, *Uscana semifumipennis* Gir., 1910.

Larval parasites:
- *Heterospilus prosopidis* Vier., 1910.
- *Lariophagus texanus* Cwfd., 1921.
- *Urosigalphus bruchi* Cwfd., 1921.
- *Glyptocolastes bruchivorus* Cwfd., 1921.
- *Horismenus* sp., 1921.

By the combined work of all these parasites, the above mentioned bruchids are now controlled to the extent that the algaroba pods are mostly free from serious injury and their value as stock food scarcely deteriorated. Probably the egg-parasite is the most effective of these parasites.

Scale Insects: There are a large number of the cosmopolitan scales which attack many kinds of trees and shrubs in orchards, gardens and lawns in Hawaii. Numerous parasites and several ladybeetles have been introduced, intentionally or otherwise, and exercise a certain amount of control, though usually not complete control. However, these scales are usually so well controlled that little effort is made to control them by insecticides. Time does not allow for taking up these individually or in detail.

As a whole the insect pests in Hawaii are pretty satisfactorily controlled by the biological methods. However, there are some not yet sufficiently controlled and thus there remains for the entomologists the problems of searching and securing more of the natural enemies for introduction. It is likely, too, that in some cases success will not be thus attained. For example: the hornfly pest on cattle seems to be a most difficult problem to solve in this way. Several attempts have been made to find and introduce parasites or predators to combat this pest, but so far, no progress in natural control has been attained. The recent introduction of a bird, *Ripidura tricolor* (Willy wagtail), from Australia, where it is noted as a valuable enemy to cattle flies, may prove of some benefit when it becomes sufficiently numerous.

THE BUD MITE (BLISTER MITE) OF THE PEAR

By WILLIAM B. PARKER, *Entomologist, California Spray-Chemical Company*

ABSTRACT

Observations on the life history of Blister Mites on pear trees, which differ in habits from those of the Pear Leaf Blister Mite are given in this paper. One reason trees that are fall sprayed with Lime and Sulphur may have many buds killed by mites and yet develop no infestation of the leaves the following spring is given. Control is suggested.

The destruction of many pear buds by what appears to be blister mites (*Eriophyes pyri* (Pagenstecher)) on trees that were fall sprayed with Lime and Sulphur and their absence in leaves or fruit the next spring led the writer to make the following observations.

Dead and injured fruit buds were found at blossom time to be infested with what appeared to be Pear Leaf Blister Mites and their eggs. Many of the infested buds were killed but there were some where one or two blossoms escaped. These were short stemmed and produced scrubby, badly russetted fruit.

When the buds were consumed the mites migrated to the bracts at the bases of the new shoots, then to the tender growth, keeping inside of the unfolding leaves. Only a very few were found on the blossoms and young fruit.

As the growth developed the mites worked on the new buds forming in the axils of the last formed leaves but well down where they were protected. They migrated upward as the twig developed and as many as eighty were counted on one bud. This severe infestation occurred on pear trees which had been thoroughly sprayed both fall and spring with Lime and Sulphur. This treatment however entirely prevented the regular blister mite injury.

When the fruit buds developed and the bud scales loosened at the top the mites were found working down inside of the first bud scales.

Eggs were present up until the last of June and were observed again the first of September. There were none found during July or August.

On October 10th the mites had not gone deeper in the buds than inside the first bud scales but by the middle of November some of them had worked inside the second layer of scales.

Buds taken from twigs where the leaves were badly blistered by the true blister mite contained large numbers of mites which had worked beneath the second bud scales on October 10th. The absence of eggs among these mites served to differentiate them from the Bud Blister Mites. The latter were also found on trees with no leaf blisters.

CONTROL EXPERIMENTS

The regular blister mite control of Lime and Sulphur applied in the fall, in the spring or both fall and spring was evidently of but little value in controlling the Bud Blister mite. Lime and Sulphur 1%; Volck from 1 to 4% and also Dusting Sulphur were tested when the new growth had reached a temporary limit. At this time the mites are mostly in the axils of the leaves and while they are well protected, they are more exposed than at any other time. All of these materials killed some mites but not enough to be considered a control and the control experiments are being continued.

Control of the Green June Beetle in a Tobacco Field A serious outbreak of the larvae of the green June beetle, *Cotinis nitida* L., occurred in a 45 acre field of tobacco during May, 1928. This is the first instance of such an occurrence to be reported in the dark tobacco belt. The infestation was heavy, varying from four to twelve larvae to the hill. The first planting had been practically destroyed and replants were being destroyed about as fast as they could be set out when remedial measures were undertaken.

For use on this 45 acre field, 1300 pounds of coarse wheat bran and 52 pounds of Paris green were mixed on a granary floor and dampened with water. This material was then bagged, carried to the field, and applied to the hills by hand. Approximately 30 pounds of prepared bait (dry weight) were applied per acre.

Frequent examinations shortly after this application showed an excellent control over the entire treated area. Replanting was resumed two days after treatment and a normal stand of tobacco was obtained.

J. U. GILMORE AND JOE MILAM, *U. S. Bureau of Entomology, Clarksville, Tenn.*

A UNIT SYSTEM FOR RECORDING THE RESULTS OF INSECTICIDES AGAINST THE CITRUS BLACK SCALE

By R. S. Woglum and J. R. LaFollette, *California Fruit Growers Exchange, Los Angeles, California*

Abstract

A unit method of orchard inspection for the citrus black scale (*Saissetia oleae* Bern.) is described. The unit is the small number of well developed scale on a branch 6 to 10 inches long. In determining the comparative value of spray materials only the lower half of the tree is inspected. This reduces the factor of faulty application, a fault most common to the top. This unit system records with equal accuracy the condition of a single tree, an orchard or a group of orchards.

The unsatisfactory results from fumigation for black scale in Los Angeles County and the sudden turning to the use of sprays as a method of control led the Pest Control Department of the California Fruit Growers Exchange to start a project in 1923 to determine the comparative value of the different insecticides used against the so-called resistant black scale. At that time upwards of 55 materials or combinations of materials were used against this pest. To determine the comparative results of 55 different materials used on commercial acreage without check plats and reach conclusions within a few months time called for a system of inspection rapid as well as accurate.

Hatching black scale settle very largely on the foliage. In the interior resistant areas where there is a single annual generation the hatch occurs during the summer, June to September. The larval insects remain on the foliage until the late autumn or winter when they move to the twigs or branches to become permanently fixed, increasing in size rapidly during the spring months until matured. For various reasons it seemed that the most logical time to make a black scale survey was in the spring after the insects were permanently settled on the twigs and branchlets and were of a size that could be quickly detected (In May and June the scale is maturing and depositing eggs). Only orchards that were heavily infested with black scale at the time of treatment and had been treated by competent operators were used. The next step was to decide on an inspection system that would record results in terms that could be accurately compared. The percentage method of determining the results on the basis of living and dead, which is almost universally used and the most accurate known where surrounded by proper safeguards, did not appear to be applicable to our situation. The numerical method, or that which indicates the degree of infestation by numbers or letters, usually 1 to 5, indicating light, moderate, heavy etc., was given trial. This method was satisfactory for making rough determinations but not suited in the form commonly used for making fine distinctions between infestations. These indexes are based largely on judgment and we were unable to locate any records where they were based on mathematical standards, or standards obtained by definite counts. Therefore, this numerical method was set aside as of insufficient accuracy for use in comparing the values of insecticides used on citrus trees. The unit system, based on counts of the number of insects per unit area of foliage or twig was given trial and finally decided on as giving the necessary rapidity and accuracy and furthermore being susceptible to easy and clear interpretation of results. After many trials, the unit selected was a scale bearing branch averaging from 6 to 10 inches long. The average number of mature scale per scale bearing branch gives the unit rating of the tree.

The next question to be determined was the number of branches or units needed in order to obtain an accurate index to the scale condition of a tree and also the part of the tree on which to take them. In the interior valleys of California black scale is confined very largely to the north or shady half of the tree. Because of this condition units are selected from the north side of the tree and for reasons explained later from the lower half of the tree. Fifteen units per tree were used in the first orchards inspected. This was dropped to ten units per tree and finally to five units per tree, which latter number our five years experience leads us to consider a minimum for making accurate record of scale conditions in infestations of varying degrees of severity. In fact, in lightly infested orchards the writers sometimes increase their units to ten per tree to be more certain of results. As previously stated these units are taken from the lower branches or skirt of the tree to as high as a man can reach with ease and one or two from the inside area of the tree. The scale on each unit is counted and the total for the five units of the tree recorded on paper or counters. Most orchards in California are in 5 or 10 acre blocks. In a 10 acre block, 40 trees are inspected in a systematic method so as to include all parts of the orchard. This makes 200 units per 10 acre orchard. The rating of the orchard is obtained by dividing the total number of scale found by the total units. Example: (10 A) 40 trees x 5 units = 200 units. If 264 scale were found living the rating for the orchard would be 1.33 scale per unit. Where several different orchards treated with the same material are inspected the rating for all of the orchards combined is quickly obtainable by dividing the total number of living scale in all of the orchards by the total number of units inspected.

Our interpretation of this method as adapted to commercial work is given in the following table taken from Bulletin No. 2 of the Bureau of Pest Control, California Fruit Growers Exchange, 1925.

COMPARISON OF VARIOUS SPRAYS TO FUMIGATION FOR RESISTANT BLACK SCALE
ONE APPLICATION

Eastern Los Angeles and Western San Bernardino Counties.

Material	Acreage	Rating After Treatment	Rating Before Treatment	Orchards Showing Improvement	Orchards Showing Commercial Control (a)
Triumph Oil Liquid lime sulphur, Casein Spreader	1239	.9	3.3	95%	88%
Sherwin-Williams Spray-mulsion and dry lime sulphur	707	1.9	4.1	73%	50%
Volck (b)	704	2.3	3.2	56%	50%
Orthol Oil and liquid lime sulphur	208	4.1	4.5	55%	25%
Fumigation	1792	4.1	3.1	30%	25%
Bejo	213	5.4	5.3	50%	19%
Success	347	6.4	3.1	14%	0
Total	5153				

(a) Commercial Control: By commercial control is meant any orchard with a rating of 1.5 scale per unit or below, as based on inspection made just prior to the scale hatch.

(b) 1924 Volck. Not Volck Concentrate.

The average sized orchard in this investigation was approximately 10 acres.

The first two seasons, 1924–1925, this system of inspection was used by the writers on upwards of 10,000 acres and at all times it was found dependable and accurate for our purpose—which was recording the comparative values of insecticides used on a commercial basis against the black scale in regions of one annual generation. It has been used on probably an equally great acreage during the seasons of 1926 to 1928. This method of inspection requires prior experience with the black scale; a knowledge of its habits and certain other factors which comes with experience. For instance, there might be old black scale shells from a previous generation scattered among the living insects of the last generation and similar in appearance. These must be excluded in the counts. And again, outside twigs or units must not be picked indiscriminately. In some orchards the scale is largely settled on the twigs in February. There might be one or even two heavy flushes of new growth between the time of scale settling and inspection. Indiscriminate selection of outside twigs would sometimes lead to the inclusion of nonscale bearing wood entirely, even though the tree might be severely infested.

Both fumigation and spraying are used in scale control. It has been known that with fumigation the scale kill averages about the same at the bottom of the tree as at the top of the tree. In our first season's inspection work with the unit system it was discovered that with spraying there was a very great difference in insect condition between the top and the bottom of the tree; that even with insecticides which produced very satisfactory results in the lower part where thoroughly sprayed, the tops were usually left very severely infested. The reason was poor application to the tops. No towers were then in use in California. Because of this condition of heavier scale infestation in the tops from lack of coverage, we have been compelled in making comparisons of the efficiency of materials, to confine our inspections to the lower half of the tree, or that part where the application is thorough and will give a dependable rating of the value of the material used.

In making orchard ratings for determining insecticide values, orchards sprayed by careless operators must be avoided. Furthermore, orchards in which the mortality of the scale between the time of treatment and the inspection is seriously influenced by outside conditions, such as a severe wind or freeze or a spraying for some other pest as spider or aphis, should be discarded from consideration.

This unit system of black scale inspection, although devised and used by us to determine the comparative value of insecticides used on citrus trees is also of value to record the actual scale condition of a tree in so far as any system can do so.

In the case of fumigated trees the scale kill is much the same throughout the entire tree. Thus, the five units taken from the bottom half of the tree, if properly selected, accurately records the scale condition of the entire tree. Also in the case of trees with the tops sprayed as thoroughly as the bottoms this ground inspection will give an accurate rating of the entire tree condition. However, where the top of the trees are more severely infested than the bottoms, a condition of common occurrence with black scale spraying, though recently greatly improved by the wide use of towers, ground inspection, while indicating the actual value of the insecticide, does not necessarily record the severity of the scale for the entire tree. Long study and experimental inspection of sprayed orchards led us to the conclusion that the only accurate method to handle such orchards was to inspect the tops as well as the bottoms and record the results separately. This we have been accustomed to do in sprayed orchards.

DISTRICT ARGENTINE ANT CONTROL IN CITRUS ORCHARDS

By Harold J. Ryan, *Horticultural Commissioner, Los Angeles County, California*

Abstract

Although an effective poison syrup formula for control of Argentine ant (*Iridomyrmex humilis* Mayr.) in California has been known for some years, the individual citrus grower has been able to make no headway toward eradication or even adequate control for any considerable length of time because of renewed infestations from untreated properties. Through a cooperative financing plan, citrus growers in Los Angeles County have made it possible for the Los Angeles County Horticultural Commissioner's office to treat all infested orchards in 45,000 acres of citrus area, poison being put out in the spring and fall of each year. A new cheap paper poison container has been developed and application costs reduced to between two and two and a half cents per container. Detailed cost figures are given for all operations. A check on the results of two years' work in 14,200 acres of orchard showed a reduction of 50% in the number of infested properties, and a decrease of 83% in the number of poison containers needed to take care of the remaining infestations.

Costs and Results of Two Years Argentine Ant Cleanup Campaign in Los Angeles County

With the gradual spread of Citrophilus mealybug (*Pseudococcus gahani* Green) in the citrus orchards of California, the need for more adequate control of the Argentine ant (*Iridomyrmex humilis* Mayr.) became more and more obvious. Following the work of Barber in New Orleans (1); the observations of Horton (2); and the experiments and demonstrations of Woglum and Borden in California (3), Argentine ant control, through the use of poisoned syrup, has become a recognized essential to successful Citrophilus mealybug control.

Aside from certain modifications in the syrup formula by commercial operators in residential areas, and adaptations of container types by these same operators to meet conditions found in these areas where material costs were not an item of very considerable importance, little attention had been given to cost saving. Orchard operations were confined usually to ten acre groves, and in those instances where larger areas were treated by one management the 1 oz. spice tin was generally used, except in work done by Swain (4) at Riverside, where he demonstrated the possibility of reducing cost by the use of a paper drinking cup container.

In 1924 the Los Angeles County Horticultural Commissioner's office undertook an Argentine ant control campaign, financed by citrus growers' associations, in the Covina section. The common one ounce spice tin was used at first, but it was found that the cost of new tins applied to the tree amounted to about five and a half cents per tin, and the labor of cleaning and reparaffining the tins made the cost of the subsequent application over four and a half cents.

The initial cost of these containers with holes punched in the sides was $14.20 per 1,000. Tests made with various paper containers resulted in the selection of a 2 oz. paraffined cup of 60 lb., double ply paper of the type commonly used for individual dinner services of candies and nuts This cup cost about half the price of the tins and could be applied to the tree under similar conditions for three and one-half cents.

Three objections were found, however. By means of a hole punched in the side, the cup was hung on a finishing nail driven into the tree, as had been customary with the spice tins. The wind swinging the cup back and forth on this nail would rub the paper at the base, and in some instances leaks would develop, causing a loss of syrup and a gumming of the tree bark where the poison penetrated. This was obviated by the use of a large paper disk hung over the nail behind the cup. At times, however, the wind would turn a cup so it would hang upside down. This difficulty was not overcome, nor was any way found to prevent the warping of the lid, which consisted of a cardboard disk fitting into the top, as does a milk bottle lid. This, when warped, allowed foreign matter to enter the liquid

Efforts to develop an improved container were successful, and a Los Angeles concern already making a glass poison jar offered to make the necessary dies and furnish an initial supply of cups at an attractive price, providing plans then being discussed for more comprehensive work were perfected.

The plans referred to, contemplated the treatment of all Argentine ant infested orchards in the eastern portion of the county, embracing some 30,000 acres of citrus, the work to be done by county employed crews, and the county to be reimbursed by the growers' cooperative packing associations for all expenses except those of inspection and supervision.

The above plan was agreed upon. Previous observers' experience had indicated that spring and fall treatment were most effective, and it was agreed to time such treatments for October and April of each year, using Woglum's modification of the formula originated by Barber:

INGREDIENTS

- 11 pints distilled water
- 2 lbs. strained honey
- 9 gms. benzoate of soda
- 12 lbs. granulated sugar
- ¼ oz. Tartaric acid (crystals)
- ¾ oz. sodium arsenite (pure, Merck's preferred)

Heat ten pints water lukewarm. Add ¼ oz. tartaric acid and stir until dissolved. Add nine grams benzoate of soda and stir until dissolved. Slowly add twelve lbs. granulated sugar—stirring constantly until dissolved. Determine exact height of liquid in container. Cover container and bring to a boil over moderate fire, and continue to boil over slow fire forty minutes, adding water to equal evaporation at end of each twenty minutes. To one pint of lukewarm water, add ¾ oz. of sodium arsenite, and stir until completely dissolved; then add to syrup and stir well. Stir in two lbs. of strained honey.

For the purpose of allocating the costs, the area was divided into six districts. The boundaries were set by the managers of the six Fruit Growers District Exchanges to include the bulk of the membership of each. Each District Exchange guaranteed to the County Horticultural Commissioner payment for all labor and materials used inside their district boundary, regardless of ownership. Each manager then made his own agreement with member packing houses, the other cooperatives, and the independent packers for payment. The work was then authorized by the County Board of Supervisors under authority granted by Sec. 4041 of the California Political Code.

Although less than three per cent of the area was infested with Citrophilus mealybug, it was deemed good business to treat all the ant infested acreage alike, with a view to checking further spread of ants at once, without waiting for the appearance of mealybug infestations to make treatment a necessity.

A complete inspection, necessarily in the summer while the ant colonies were active, was first required, but was begun too late to allow for complete inspection of all districts in the summer of 1925. Treatment of uninspected districts was, therefore, postponed until 1926.

Inspections were completed in the three districts of Azusa, Covina, and Glendora, which include a total of 14,200 acres of practically contiguous citrus plantings lying just east of the San Gabriel River.

Preliminary inspection consisted of scouting along roads and ditches throughout the area, taking advantage of the known habit of the ant of clinging to borders of orchards and to house yards.

At this time all specimens of ants, other than *I. humilis* were taken, and were identified by P. H. Timberlake as follows: Subfamily Myrmicinae, *Monomorium pharaonis* Mayr., *Pogonomyrmex californicus* Buckley., *Messor* sp. probably *M. pergandei* Andre., *Solenopsis geminata* Fabr. var. *maniosa* Wheeler., *Pheidole* sp., Subfamily Dolichoderinae, *Iridomyrmex humilis* Mayr , *Tapinoma sessile* Say., Subfamily Formicinae (or Camponotinae), *Prenolepis imparis* Say., *Prenolepis* (Subgenus *Nylanderia*) sp., *Liometopum apiculatum* Mayr., var. *occidentale* Emery, *Myrmecocystus* sp., three other *Formica* spp.

Where the Argentine ants were abundant, other species were always absent except occasionally at the borders of infestations.

The general areas of infestation having been determined and mapped, a detailed inspection was made of each orchard within the infested area and a card index made showing a chart of the orchard and showing the location of trees tended by ants and two rows beyond.

In practically all instances the areas of infestation within the orchard were found to prevail along the borders, centering especially about ornamental plantings along the driveways and around the houses. At the same time a record was made of the average degree of ant infestation in each grove, No. 1 being used to designate a light, No. 2, a medium, and No. 3 a heavy infestation. A standard measure for these grades was based upon the number of ants in one stream crossing a given line on the tree trunk in one minute of time. One to ten ants crossing in that time indicated a light infestation, eleven to thirty inclusive was graded as medium, and thirty-one or more as heavy.

This standard was set at noon with the orchard temperature at near 85° F. Without further work to determine ant activity at various temperatures and under various climatic conditions, this remains still a crude method, but with a little experience and this standard, a careful inspector was able to grade with excellent accuracy so that results of frequent reinspections by others agreed with his findings quite consistently. The only exceptions were in the case of a few orchards inspected during cool wet weather. These, upon recheck, were found to be under-graded as to both degree and extent of infestations.

The cost of inspection and supervision as previously stated was borne by the county. From July 1, 1925 to June 30, 1927, about $2,900 of the supervising inspectors' salary and expenses was chargeable to work in the three districts. Original detailed surveys made in 1925 cost approximately 17c per acre of citrus inspected. Later reinspections of actually infested acreage cost slightly over 10c per infested acre.

There was considerable variation in the amount of ant infested property in different districts. The Glendora district, for instance, with 3,805 acres of citrus had properties infested totaling 2,601 acres, or 68 per cent. The average number of trees per acre in this region is about 80. On this basis the 73,991 trees found in need of treatment represented 36 per cent of the trees on the infested properties. Of the 5,645 acres around Azusa, 2,086, or 37 per cent, were on infested properties with 49,729, or 30 per cent, of the trees infested. In the Covina section of 4,750 acres, 38 per cent of the property acreage was infested, and 24 per cent of these trees on infested properties had ant colonies. This would seem to indicate that the Argentine ant has been established longer in Glendora than in the other districts, as their chief source of food supply, black scale (*Saissetia oleae*) is about equally distributed in all three areas. The total number of acres of infested properties was 6,485, with 157,344 infested trees.

Headquarters for syrup manufacture and supply distribution were established and work begun October first, and completed November fifteenth with a crew of seventeen men and a supervising inspector.

A separate crew worked from a selected place of operation in each of the Covina, Glendora, and Azusa areas. The crews consisted of four men and a foreman each, with the exception of Glendora whose crew consisted of six men and a foreman. Because of the larger area to be covered it was thought best to use six men in Glendora instead of four, in order to finish treatment before the winter rains started.

The duty of each foreman was to keep a record of all materials used, the number of containers placed in each grove, number of containers filled, and hours of labor for the crew. He filled all of the containers for the crew, kept the field cards in order, and transferred the crew from one grove to another. It was necessary for each foreman to have a car in order to obtain supplies and transfer the men in the field. For this service he was paid six cents a mile. The wage was four dollars and a half ($4.50) per eight hour day for the foreman, and four dollars ($4.00) per day for the laborers.

The men were divided up into teams of two men each, and at least a half-day's work was planned ahead for them in one locality so that the foreman would only have to move them once a day in the field. It was planned to do this at noon when new supplies were taken out for the afternoon. This system proved very satisfactory in economy for both time and auto hire.

Sixteen carriers holding two trays each were made and also approximately one hundred trays. The trays constructed of light wood and holding eighty-four containers each were so made that they could be stacked one upon the other when filled with containers. Very little tipping over of the containers in the trays was experienced although it was at first anticipated that wires would have to be strung across them to hold the cups erect.

Carpenter's aprons, used by lumber companies for advertising purposes, were given to the crews for carrying their brackets and nails, and were very satisfactory in that they did not get in the laborer's way and proved large enough to carry a half-day's supply.

The equipment used for making the poison syrup in 1925 proved quite satisfactory and is essentially the same as that still in use in 1928. It consisted of a set of balance scales, a three burner gas stove, two 20-gallon copper vats lined with tin, and various sizes of liquid measures. The poison can be made in lots of fifteen gallons. When prepared, it is placed in five-gallon bottles. From these bottles, placed on a raised shelf, the syrup is siphoned into the field containers as needed.

The field container used is a two and one-half ounce cup of heavy weight 90 lb. paper, well paraffined. It is one and three-quarter inches deep with a diameter of two inches at the top and one and seven-eighths at the bottom. The proportions and formation are those of the common table-glass shaped, paper drinking cup. Just under the rim are punched four holes, one-eighth inch in diameter, to allow entrance of the ants. The top is a slip-over lid of the same material, with the bottom edge crimped so that it will lock when pushed down over the cup rim. Certain features are patented by the manufacturer.

The cup is hung upon the tree by a metal bracket designed to successfully prevent rubbing against the bark, or tipping. While some extra labor is entailed in the first application because the bracket must be affixed to the tree with a nail, subsequent applications consist of merely removing the old cup and hanging a new one. The old container may then be set (upside down to avoid tipping) upon the ground for such ants as may choose to feed upon the remaining syrup.

In order to introduce the new container, and upon agreement of the growers that they would finance the campaign to the extent of a million containers, a special price of $8.00 per thousand for the cups and $3.75 per thousand for the brackets was made.

The itemized costs of all operations for the fall of 1925 are as follows:

Containers 157,344 at $8 per M	$1258.75
Brackets 157,344 at $3.75 per M	590.04
Nails 201 lbs. at 14.75 cwt	29.52
Syrup 747 gal.—Materials	303.90
Labor at 50c per hr	74.70
Cartage	17.01
Rent	30.00
General labor at $4.50 and $4.00	2134.49
Auto hire of crews at 6c per mile	146.94
Total	$4585.35
Average cost per container applied to tree	.0291

The costs of application, however, were not uniform in all three districts, as they varied from 2.7 cents per container in the Glendora district, where the infestations were heaviest, to 3.0 cents each in the Covina district, and 3.1 cents in Azusa, where more time was lost proportionately moving from one place to another.

This point is further illustrated by the fact that the average number of containers with brackets placed in the orchard per hour varied from 51.1 per man in Glendora to 41.6 in Azusa. One man could fill about 325 cups per hour.

These same areas were treated again in April of 1926, at which time the ants were found to be quite active. The total cost was reduced to $2,838.99, or an average of 2.1 cents per cup, due chiefly to saving in bracket costs and labor of applying them. The speed of cup application was increased to 68 per man per hour in Glendora. It was found that by having one man alone all the time, instead of different men at different times, filling cups in the central station that this operation could be speeded up to over 450 per hour.

No reinspections were made the following summer, but new areas were mapped, and in the fall of 1926 there were added a number of small areas and three large ones, placing 36,000 acres under the control system, and using 293,633 containers at an average cost of 2.57 cents each, including new brackets. The costs in the three areas previously treated remained practically the same, as was also the case for the fourth treatment applied in the spring of 1927.

The syrup has been thoroughly satisfactory. It proved attractive to the ants at all times when weather allowed them to feed, except only for short periods—never apparently more than a few days—when honey dew was being secreted in unusual quantities by scale insects.

In some instances syrup was covered with dead ants, but never in a sufficient number of containers to materially affect feeding. After the third and fourth treatments, many cups around the outside edges of the infestations remained untouched, indicating that some colonies had been materially reduced.

At the rate of 200 containers per gallon of syrup, no orchard infestations of Argentines were heavy enough to empty the cup, though where colonies of the Honey ant (*Prenolepis*) occurred, they would raid the poison and completely empty the containers.

In the spring campaign of 1927, 45,800 acres of citrus were under treatment in the county, and 357,826 containers were used at an average cost of 2.1 cents each, applied to the tree.

The areas under immediate consideration showed an average container cost for the four treatments of 2.5 cents in Covina, and 2.2 cents in Glendora and Azusa.

An inspection of all properties in these three districts was conducted in the summer of 1927, showing a marked reduction in number of properties infested and number of trees infested, as compared with conditions in 1925.

No. of Properties of Various Degrees of Infestation

	1925		1927	
	No. of Props.	% of Total	No. of Props.	% of Total
No. 1	118	21	232	82.8
No. 2	232	41	41	14.6
No. 3	122	22	7	2.6
Not graded	90	16	—	—
	562	100	280	100.0

Seven heavily infested groves were found in 1927, whereas there were at least 122 in 1925. The number of medium infested groves had also materially decreased, while there were more lightly infested groves than there were before poisoning began.

	1925	1927	Reduction
Properties infested	562	280	50%
Acres infested	6,485	3,593	44%
Trees infested	162,894	27,420	83%

Of the original number of 562 property infestations, 50 per cent appear to have been entirely eradicated in two years time.

Eradication was obtained in 73 per cent of the original 118 lightly infested groves, while of the medium infested groves, 48 per cent were free of ants in 1927, and 38 per cent of the heavily infested groves were entirely cleaned up.

The series of four treatments had used 590,000 cups, and cost for the 14,200 acres in the Azusa-Covina-Glendora area $13,567.53, or somewhat less than one dollar per acre. If the cost had been assessed against the 6,485 acres of infested properties alone, it would have amounted to approximately two dollars per acre, or fifty cents per acre per treatment. The cost of the treatments averaged $3,391.88 each, and the effect on the ant population made it possible to poison the same region again for $1,100 in the fall of 1927.

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THE COACHELLA VALLEY (CALIFORNIA) HIPPELATES FLY PROJECT

By W. B. HERMS, *University of California*

ABSTRACT

Since the opening of this project in June 1926 frequent trips have been made to this valley for the purpose of determining the breeding habits of *Hippelates pusio*, a very annoying and abundant insect. Although a careful study has been made of many situations, its source still remains a mystery. Due to the very high summer temperatures of this dry region the lack of suitable laboratory facilities has proved a distinct handicap. With funds voted by the Riverside County Board of Supervisors an adobe laboratory suitable for desert investigations has now been built for this project, and funds for maintenance will be provided by an abatement district.

Under date of May 20, 1926 a number of residents of the Coachella Valley (California) petitioned for assistance in the control of a fly termed a "buzz gnat" which was said to be seriously annoying and believed to be an important vector of a type of "pink eye." The writer undertook to investigate the situation and made a trip to the valley June 6–7 of that year. The fly was at the time identified as *Hippelates* *flavipes* Loew.[1] In a letter from Dr. J. M. Aldrich dated May 19, 1927, he writes, "The species which you sent from Coachella Valley, California is *pusio* Lw. It is the same species which was identified as *flavipes* Lw. by Malloch, Proc. U. S. N. M., 46, 1913, p. 245. His 'variety *pusio* Lw.,' on page 246 is a different form. The true *flavipes* of Lw., is the one described by Malloch on p. 243, as *nitidifrons* new species, as I have ascertained by examining the types in the Museum of Comparative Zoology at Cambridge, Mass. The earlier literature is somewhat uncertain since the time of the original description, but probably your species is the same one that has been referred to as *flavipes* when mentioning its annoying habits." In the same letter Dr. Aldrich also writes, "In the Proceedings of the California Academy of Sciences, Vol. 4, 619, Townsend described *Oscinis collusor* from Lower California which he said was reported to cause irritation of eyes of travelers and the 'mal de ojo' of natives. I examined his types in the Academy shortly before their destruction by fire in the spring of 1906 and found that they belonged to the genus *Hippelates* and it is quite probable that the species is *pusio*." The writer has traced the Coachella Valley species through to the Mexican border at Mexicali.

During the summer of 1926 a temporary laboratory for the study of this fly was established on the Williamson ranch at Coachella and it was largely through the courtesy of Mr. Geo. Williamson that operations were at all possible during a portion of that summer with Mr. W. C. Beckley on the ground and also a portion of the summer of 1927 with Mr. R. E. Barrett in residence. Each of these summers the writer together with members of his staff made many trips to the valley for longer or shorter field investigations. It soon became apparent that more suitable laboratory facilities must be provided particularly because of the very high summer temperatures and desert conditions. Much credit is due Mr. E. P. Carr, Chairman of the Coachella Valley Citizens Committee for his continuous intelligent interest in the project. Had it not been for the interest and constant encouragement of both Mr. Carr and Mr. Williamson the Coachella Valley Hippelates fly project could not have prospered. Through these gentlemen the Coachella Valley Lions Club became interested and preliminary funds were provided for the investigation and later the project placed on a more permanent basis through the establishment of an "Abatement District" and the granting of funds for the construction of a laboratory by the Riverside County Board of Supervisors.

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[1] Herms, W. B. Hippelates flies and certain other pests of the Coachella Valley, California. Jour. Econ. Ent., Vol. 19, No. 5, pp. 692–695. (Oct. 1926).

The Abatement District was organized and established March 15, 1928 under the act of May 29, 1915, California Assembly Bill No. 1565, Chapter 584, and includes almost the entire Coachella Valley. This act provides "for the formation, government, operation and dissolution of mosquito abatement districts in any part of the state, to facilitate the extermination of mosquitoes, flies and other insects; and to provide for the assessment, levy, collection and disbursement of taxes therein."

In designing the laboratory it was necessary to take into consideration a number of factors, principal of which was the extreme heat,—with summer temperatures rising to over 120° it was necessary to achieve a degree of comfort for the worker as well as prevent too rapid desiccation of experimental material, to this end a structure with thick adobe walls seemed to be most practical. The design, for which my colleague Prof. C. W. Woodworth is largely responsible and who also was later detailed to put the same in effect, has proved fairly satisfactory for the intended purpose. The laboratory (Pl. 17 Fig. 1), in reality a desert entomological laboratory, was constructed during April of this year (1928). With the temperature ranging well over 110° in the shade outside, much of this paper was written in comfort in the new laboratory. Thick (12 inches) adobe walls, an air space above and a sprinkling system (used only a few minutes several times during the day) both in the breeding chamber gallery and on the lower laboratory roof, achieved the good result. The adobe walled cool chamber is in the form of a letter T, the long narrow chamber having an inside length of fifteen feet and that of the anterior space nine feet.

During the greater part of April (1928) Mr. D. C. Parman, Assistant Entomologist, Division of Insects Affecting Man and Animals, Bureau of Entomology, was stationed at Coachella to investigate the possibility of trapping these flies. Various types of traps were used such as glass box traps and glass jar traps of various sizes baited with such material as hog liver and kidney of various ages, beef slime, blood, and sundry chemicals. This species of Hippelates fly is particularly attracted to animal secretions and excretions. It is no doubt this attraction that accounts for this gnat's role in the transmission of ophthalmia,[2]—moisture from the eye being very attractive to it. The work which Mr. Parman did has encouraged us in continuing along that line in addition to the search for the source of the gnats.

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[2] Schneider, Albert. An introductory report on pseudo-trachoma endemic in the Salton Sea region of California. Med. Sentinel, Vol. 35, No. 3, pp. 154–161. (Mar. 1927).

Although liver, "hamburger," kidney, moistened dried blood and tankage prove very attractive to these insects, which feed to repletion on the same, no oviposition was observed. Bermuda grass appears to be very attractive, but so far no immature stages have been found in this grass, its stems or roots. Cotton, onions, dates, tamarisk, saltbush, ditch ooze, soils, and many other possible sources have been tested,—all without effect. However, the search will continue with vigor and with much improved laboratory facilities, the project should show good progress during the present summer.

THE TERMITE PROBLEM OF THE PACIFIC COAST

By S. F. LIGHT, *University of Califronia*

(Paper not received.)

Mr. E. H. Ehrhorn stated that termites are a very serious problem in Honolulu. For the subterranean forms, very successful control has been obtained by locating the nests and fumigating them with carbon bisulphid. Recently the use of Paris Green, forced into the nests and runways by a special dust gun, showed considerable promise. Termites had been found damaging barges and ships, which were successfully fumigated with carbon bisulphid. Even the woodwork of Automobiles has been attacked.

INSECTS vs. POLIOMELYTIS: NEGATIVE EVIDENCE

By R. W. DOANE, *Stanford University*

ABSTRACT

Early in 1928 a light epidemic of Poliomelytis on the Stanford Campus afforded an opportunity to make a study of the possible relation of insects to the spread of this disease. As a result of these studies it was concluded that insects were probably not concerned with the spread of this epidemic.

About January 25, 1928 a case of poliomelytis was discovered in the girl's dormitory on the Stanford Campus. This case was quickly followed by others until by January 28 six cases were reported from this dormitory. During the next two days two other cases were reported on the Stanford Campus. One from a sorority house and another from a fraternity house. This sorority house and this fraternity house were just across the street from each other, but they were a quarter of a mile distant from the girl's dormitory. All of the cases were very light, and as serum was used at once the patients all responded very quickly and were soon in normal condition, although, as a matter of precaution, they were kept in quarantine during the usual period of two weeks.

Although every effort has been made to find the source of this mild epidemic we have not been able to find any clue whatever that would aid us in determining how the disease appeared on the Campus, or how it was spread.

The girls in the dormitory were not closely associated except that they were in the same large building. They did not all eat in the same dining room and were not together socially and did not all attend the same classes. This seemed to be a very good opportunity to find whether insects might have been in any way concerned with the spread of this disease in this epidemic, and a thorough inspection was made of the dormitory and vicinity.

The matron at the hall told me that the girls were not associated with each other in any way; that their rooms were not near each other, and that they did not use the same bath rooms or toilets. An inspection of the room where one of the cases occurred showed that it was on the ground floor on the east side of the hall; the window was eight or nine feet above the ground and screened, but there was a very large hole in the screen. A careful examination showed no insects in the room the day after the case was discovered.

In one of the other rooms on the second floor on the west side of the hall just above the dining room the window had been left open and several insects were found in the room. The most abundant of these insects were small species of Chironomidae and Cecidomyiidae, none of which were biting insects. A few house flies and one mosquito, *Theobaldi incidens*, were also present. As the windows of this room had been open for two or three days these insects may all have entered after the patient was removed. Another room on the third floor was visited the morning after the patient had been removed; no insects were found in the room. This room was also near the dining room and was situated about thirty feet from the second room just referred to. Another room on the third floor was also near the dining room on the back side of the dormitory. The fourth room was also on the third floor, opening on the back court. This room was being fumigated with formaldehyde at the time of my visit, so I could not go in. The first case occurred here.

The matron told me that after the patient was taken to the doctor for an examination she was immediately taken to the isolation hospital without returning to her room. The matron later in the evening went into the girl's room and made up the bed without changing the linen, intending to have it changed the next morning. A girl friend of the patient, not knowing about her friend's illness, came into the room and, finding the bed vacant, went to bed and slept there over night. This girl was carefully watched, but showed no indication whatever of any illness. The other room that was visited was on the first floor facing the front court. The screen on the window was torn at the bottom, and many minute Cecidomyiidae were found on the window.

The same day that I inspected these rooms I did some collecting on the dormitory grounds and along the lake side near by. A few Empididae were dancing near some bushes just east of the hall. A few Argentine ants were crawling on the walls of the dormitory. Along the lake shore several Chironomidae were flying and a few were taken in the net. No mosquitoes were seen. At the stable in the corporation yard one-eighth of a mile from the dormitory I found a number of house flies around the stalls.

The next day inspections were made in the sorority and fraternity houses in which cases had occurred. Only eight girls were living in the sorority house. They all eat together and are, of course, very closely associated.

The patient had complained of a cold and a headache for a few days before she went to see the doctor, and in spite of the fact that she seemed to recover very quickly after the serum treatment she was isolated with the other patients. She shared her room with another girl, but slept alone the night before she was taken to see the doctor. There was no screen on the window of the room in which this girl lived. An examination of the kitchen showed a few house flies, but no cockroaches or other insects that I could find. The girls's room had no insects in it. A Chinese cook is employed at this house.

There were about twenty-five men in the fraternity house where the last patient was found. These men all ate together in a common dining room and many of them slept together in a large upper room, having their study rooms separate. The cracks in the floors in the sleeping room were wide open in many places. An Airdale dog has the run of the house and sometimes comes up to the sleeping room. The windows of all of the rooms were open, and a number of house flies were found in the rooms. An examination of the kitchen showed a number of house flies, but no cockroaches or other insects were found. Negro cooks and waiters are employed in this fraternity house.

The following day an inspection was made of the dining room and kitchen and store rooms in the girl's dormitory. There are two dining rooms, both exactly alike, each one located on either side of the kitchen. The tables are arranged with chairs for eight persons. There is a boy and a girl waiter, both students, for each table. White women do the cooking. There are one or two white men in the kitchen who do some of the heavy work. Everything about the kitchen was very clean. Only five house flies were seen here. A few Argentine ants were seen in the meat room and along the side of the kitchen devoted to baking. The store rooms down stairs were very clean. A few Argentine ants were found in the basement and some in the store rooms. The lady in charge of the dining rooms and the kitchen says that the ants have been more troublesome this winter than ever before although they have been using ant pastes and ant powders freely. She says too that in the past several of the girls have complained of having been bitten by ants. I was not able to confirm this report.

In one of the store rooms two heads of "dry jack" cheese were found to be badly infested on the outside by cheese mites. These mites were in all stages of development, and a ring of brownish castings covered and surrounded the cheese. A large head of Oregon full head green cheese on the same shelf some distance away had a few of the mites on it Other small packages of cheese were also found to be slightly infested. One-half of the cake of "dry jack" cheese that had been in the meat refrigerator for about four weeks was also found to be infested. As the meat is held in this refrigerator for only a short time the temperature is quite high. A reading showed the thermometer to stand at 50°F.

Mouse traps were placed throughout the kitchen and store rooms in the dormitory and in the infected fraternity and sorority houses. Two rat traps were placed near the garbage cans outside the kitchen door at the dormitory. These were all baited with cheese and visited late in the evening and early in the morning for two days. Six mice were caught in the dormitory, five in the fraternity house and none in the sorority house. The mice that were caught early in the evening were immediately placed in bottles to be examined the next morning. Some of them were still warm when caught. All of the mice taken from the traps in the morning were cold and rigid. No parasites were found on any of these mice. The rat traps were undisturbed. The store house man at the dormitory told me that they have not been bothered with rats for a long while.

As a result of these studies I have reached the conclusion that insects were probably not concerned in the spread of this epidemic of poliomelytis on the Stanford Campus during the last few days of January 1928. The only insects that were present in any numbers in all of the houses were Argentine ants, and as they are not any more abundant in these houses than in others in this vicinity, and as their presence was not noted in the living rooms of any of the patients I do not, at present, see how they can be held responsible for the spread of this outbreak.

SPECIFICATIONS FOR PETROLEUM OILS TO BE USED ON PLANTS

By E. R. DEONG, *Mills Building, San Francisco, California*

ABSTRACT

Certain of the older specifications, such as flash point, color and gravity, for defining petroleum lubricating oils are apparently of little value for evaluating oils suitable for spraying purposes. In place of these, other characteristics including, sulfonation value, volatility and oxidation value are defined and laboratory methods given for determining same.

Certain technical features of petroleum oils were brought before this body through your Journal,[1] about two years ago but with the continued interest in this subject and at the risk of repetition, I would again, like to call to your attention the need of exact specifications for oils to be used in spraying plants and attempt to interpret certain of these.

Much has been said in recent years as to the comparative merits of "quick breaking" vs. stable emulsions but I believe the recent findings of Griffin[2] et al have established the merits of emulsions of this type rather than those containing minute oil globules in a permanent type of emulsion, hence no attention will be given to this phase of the subject.

The entomologist, in his attempts to use petroleum oil, as a weapon of defense, either for his own body, e. g. against the mosquito or to protect growing crops has been compelled to borrow certain specifications from the lubricating oil trade to define the fractions which he wished to consider. "Ready made" or borrowed terms are frequently as poor a "fit" as are many clothes of the same description, hence we have the need of discarding certain terms and substituting others which convey our ideas more properly.

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[1] E. R. deOng "Technical Aspects of Petroleum oils and oil sprays." Jour. Econ. Entomology XIX:733–745 (1926).

[2] Griffin, Edward L., Charles H. Richardson and Robert G. Burdette, "Relation of size of oil drops to toxicity of petroleum oil emulsions to aphids." Jour. Agr. Research, 34:737–738 (1927).

In discussing such terms, I merely want to enlarge upon certain points but not to depart from the original classification as laid down by Gray,[3] namely, (1) chemically inert hydrocarbons of the paraffin and naphthene series, and (2) chemically active hydrocarbons of the aromatic series and of the olefin series (cracked oils). Series (1) has usually been spoken of as "saturated hydrocarbons" and (2) as "unsaturated hydrocarbons" even though the aromatics are included in the latter.

Certain specifications, applied to lubricating oils, are apparently of little use in the evaluation of oil for spraying purposes and apparently should receive but slight consideration or be entirely discarded. Included in these are, gravity or density expressed as Baume degrees, flash point, fire point, pour point and color.

Color must be considered either of doubtful significance or deceptive. The heaviest shades of petroleum oil are largely due to inert suspended particles and their presence or absence is of little consequence. They may be removed by filtration and leave the oil almost colorless and yet it would be very dangerous for foliage use. Refining an oil with sulfuric acid or liquid sulfur dioxide removes these particles and at the same time the olefins and aromatics, hence to a certain extent color may be of some significance.

Sulfur in whatever form it may be present is usually considered a hazard to the plant even as low as 0.05 per cent. Combinations of certain types of commercial emulsions and free sulfur are sometimes recommended but a wide observance of this principle cannot be recommended in our present state of knowledge.

The fractional distillation of an oil at varying temperatures indicates the quantity and density of the fractions distilling between ranges of temperatures at stated intervals. Distillation is sometimes taken as an indicator of volatility and is very intimately associated with this characteristic. Distillation, however, usually begins between 150° and 300° C. and ranges as high as 400° C. (at which time decomposition or cracking begins); it is of little significance in field work except as an indicator of the proportions of volatile and non-volatile oils.

VOLATILITY

The volatility of spray oils is an important factor closely associated with viscosity. Much of the value, as well as, the difficulties attending oil sprays are associated with these two characteristics. They also form the basic distinction between kerosene and lubricating oil. The former is ineffective against most insect eggs and resistant scale insects, because of its rapid rate of evaporation and the possibility of its expulsion from the tracheae, while lubricating oil, once it penetrates, persists for a long time in the breathing tubes. The action of the two oils on leaf surfaces is very similar to that in the body of the insect, kerosene penetrating rapidly and without leaving a greasy film on the leaf surface, while the lubricating oil may be present on the leaf surface for days and persist in the leaf for weeks and months, acting as a repellent or toxic agent during this time.

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[3] Gray, G. P. and E. R. deOng. "California petroleum insecticides." Inds. and Eng. Chem. 18:175–180 (1926).

The following test has been devised, in cooperation with the chemists of the Shell Company of California, as a laboratory method of determining volatility:

The test consists in determining the rate of evaporation of the oil sample concerned from a standard grade of asbestos paper suspended in an oven kept at a controlled temperature, ranging from 50° to 100° C., according to the oil fraction used. A weighed amount of the oil sample, usually 0.5 gm., is placed on a sheet of the asbestos paper, three inches square, and weighings made of duplicate samples every 24 hours. Thermostatic control of the temperature is necessary. The evaporation of 95 to 100 per cent of the sample used is required to determine the curve. Comparatively large amounts of the samples are necessary to indicate differences at this slow rate of volatilization. For these reasons it is considered best to use temperatures of 50° to 100° C. A range of this magnitude is best where the field includes both kerosenes and light lubricants. The suggested amount of 0.5 ± gm. per sample is sufficient to give accurate readings at more rapid rates of volatilization.

SULFONATION TEST

The sulfonation test has been devised for determining quantitatively the proportions of the chemically inert hydrocarbons of the paraffin series and the chemically active hydrocarbons of the aromatic and olefin series, these two classes having been found to be the basis for the most exact grouping of tolerable and intolerable fractions. Since all but the most highly refined distillates are mixtures of these two classes it seemed desirable to determine their exact proportions in refined and unrefined distillates.

VISCOSITY

The viscosity or freedom of motion of the molecules of an oil, often spoken of as "body" or "fluidity" is an important property in the selection of a lubricating oil. This property is often expressed as the rate of flow through a definite orifice at a standard temperature in comparison with that of water as the standard. Viscosity has frequently been used as an indicator for volatility, since it is a standard test for all oils, but there are many conditions under which the two attributes are not uniform, particularly in the movement of oils in the tracheae of an insect and in the internal structure of a leaf.

Viscosity is a valuable characteristic both from the standpoint of evaporation and penetration. The latter factor applies both to penetration into the tracheae of the insect and entrance into the leaf and twig. Oils of the kerosene type are known to pass rapidly through the entire tracheal system of the insect and may in this way carry other and more active insecticides.

Viscous oils of 100 sec. Saybolt[4] penetrate the tracheal system very slowly. They are however, fixed so firmly that they cannot be dislodged, probably causing such a degree of suffocation as to contribute to the death of the insect. The viscous oil also is difficult to remove from the leaf, once it has entered, thus leading to functional disturbances and possibly through oxidation to acute injury.

The present trend in sprây practice in southern California is strongly towards oils of viscosities of 35-80 sec. Saybolt, the lighter form being for the black scale and the heavier for the red scale and red spider, also for use on deciduous trees. The report of R. S. Voglum, Entomologist for the California Fruit Exchange, shows, for the year ending June, 1927, that non-coloring of fruit and non-setting of bloom was practically eliminated the past year (June. 1926-June, 1927) with the general use of light oils. For the year ending June, 1926, the work was mostly with an oil of 100-110 seconds viscosity, and serious difficulties were encountered especially when applied in the fall and winter.

OXIDATION

The Sligh[5] method of determining the degree of oxidation in lubricating oil has been the basis for the work on oils for use on plants. The method has been modified to this extent that the degree of oxidation is measured by the amount of acidity developed rather than the measurement of a sludge precipitate, which is a later stage in the oxidation process. The procedure is essentially the same as the original method given below, excepting the use of a temperature of 150° C. instead of 200° C.

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[4] All viscosities given are at 100° F.

[5] Sligh, Jr. T. S. "An oxidation method for measuring the stability of mineral oil." Proceedings American Society for Testing materials. Vol. 24, pt II (1924).

The method of procedure for the test is as follows:

"Ten grams ± 0.1 g. of oil are weighed into a standard oxidation flask. The air in the flask is displaced with oxygen at approximately 760-mm. mercury pressure and 68° F. and the slightly greased stopper carrying the connection plug is clamped in place. The flask is immersed vertically to a point about 1 in above the body in a well-stirred oil bath maintained at 300° C. ± 1.0° C. and held at this temperature for 2½ hours. The flask is removed and allowed to cool. The oxidized oil is diluted to a total volume of 100 cc with petroleum naphtha. After 24 hours this solution is filtered and the weight of the precipitate is obtained."

Two oils were oxidized according to the above method and the acidity determined by titration. The method being as follows: 50 cc. of the oil were added to 50 cc. of 95 % alcohol and 50 cc. of 0.1 N. NaOH and the mixture refluxed for one hour. The excess hydroxyl concentration was then titrated with 0.1 N. HCl with phenolphthalein as the indicator.

Experiments[6] made by the above procedure and also by exposing oils in their films to the action of the air and sunlight, have shown that oils of almost 100 per cent concentration of saturated hydrocarbons may break down and yield such quantities of acid as to be decidedly injurious to foliage. In the study thus far made, it has been found that oils differ greatly in their resistance to oxidation and it is possible that this factor may have sometimes entered into known instances of oil injury.

CONCLUSIONS

It will be noted from the above statements that no single specification will sufficiently describe oils suitable for use, particularly on foliage. Two or more characteristics are required to define an oil even according to our present knowledge. Sulfonation value in connection with volatility and viscosity and perhaps the stability as shown by the oxidation test are all of value. The possibility of light petroleum oils as carriers for other and more active insecticides, such as nicotine and possibly pine oil as a solvent for nicotine, are factors for further study.

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[6] In cooperation with the Shell Company of California.

SUMMARY

Petroleum oils for use on foliage at summer temperatures should, according to experimental results in California, have an unsulfonatable residue of 88 to 99 per cent. The lower percentage being permitted only with oils of low viscosity 40 to 50 seconds Saybolt and decidedly volatile. These oils should also be stable chemically and not oxodize readily.

Oils for foliage use at low temperatures e. g. max. daily temperatures of 45° to 60° F. may be of a more viscous and less volatile form, thus reacting for a longer period of time. Such oils are apparently more effective both for resistant insects such as the red scale and on insect and mite eggs.

Oils for dormant use on deciduous trees should have an unsulfonatable residue of 65 to 75 per cent and a viscosity of 85 to 120 seconds Saybolt. There is apparently less danger from oxidation products in oils for use on dormant trees than those for foliage use at comparatively high summer temperatures.

Lowered insecticidal value resulting from the use of highly refined and somewhat valuable oils may be compensated for, in part, by incorporating other and more active chemicals such as nicotine. Specially refined pine oils may also be found useful as solvents for nicotine in blends with petroleum oils, particularly for citrus trees.

THE EFFECT OF CERTAIN HARD WATERS ON THE STABILITY OF COLD MIX LUBRICATING OIL EMULSIONS[1]

By J. R. EYER and F. M. ROBINSON

ABSTRACT

In an attempt to ascertain the cause for separating out of "cold mix" oil emulsion stocks on dilution with certain of the hard waters in New Mexico, it was found that a modification of Herschell's demulsibility test could be applied for determining the rate of separation in these mixtures. This test, when applied to oil emulsions made from hard waters containing magnesium sulphate in amounts greater than 5 parts per 100,000, showed that the separating out of the oil was in proportion to the amount of magnesium sulphate present, leading to the conclusion that this chemical was largely responsible for the instability of the emulsions in the types of water observed. Calcium sulphate and sodium chloride, also normal constituents of New Mexico hard waters, did not affect the stability of emulsions.

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[1] Contribution from Biology Department, New Mexico College of Agriculture and Mechanic Arts.

INTRODUCTION

The authors' attention has been recently called by fruit growers of New Mexico to the occasional difficulty of securing stable lubricating oil emulsions when using certain local waters and the standard "cold mix" emulsion formula. In preparing a four per cent oil emulsion from this formula four gallons of lubricating oil, one and one half gallons of water and eight ounces of a casein spreader (Kayso) are emulsified to form the stock solution and this is then diluted in one hundred gallons of water. The chief difficulty encountered by the orchardists when preparing this mixture was a separation of the constituents when they were diluted in the spray tank so that during the spraying operation some of the trees received an over dosage of oil and emulsifier and the remainder received little more than a coating of water.

Observations of the field methods used by the orchardists having this difficulty convinced us that the instability of the emulsions was attributable to the water used rather than to carelessness in following the formula. Most of the water used for spraying in the region where these observations were made came from irrigation ditches using the Rio Grande river as their source of supply or from drilled wells on the property of the orchardists. With the latter the type and degree of hardness varied considerably but in the river water the hardness was fairly constant over a yearly period. In either case, however, this hardness was frequently of a permanent type and the samples contained some or all of the following: sodium sulfate, sodium chloride, calcium sulfate, calcium chloride, magnesium sulfate, magnesium chloride, and potassium sulfate. In practically all samples of the permanently hard type magnesium sulfate, calcium sulfate and sodium chloride formed a large share of the mineral matter present.

DISCUSSION OF METHODS AND RESULTS

In order to test the reaction of such waters when used to dilute an emulsion stock prepared as above described, a modification of Herschel's demulsibility test as recommended by the U. S. Bureau of Standards[2] was used. In the unmodified method a known quantity of oil, usually 27 cc. is placed in a 100 cc. graduated cylinder and sufficient distilled water is added to bring the quantity up to 100 cc. The mixture is stirred for five minutes with a standard paddle running at 1500 R.P.M. The rate at which the oil settles out from the emulsion when it is allowed to stand at 130° F. is the measure of the emulsibility of the oil and an

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[2] U. S. Bureau of Standards: Bul. 86, 1917.

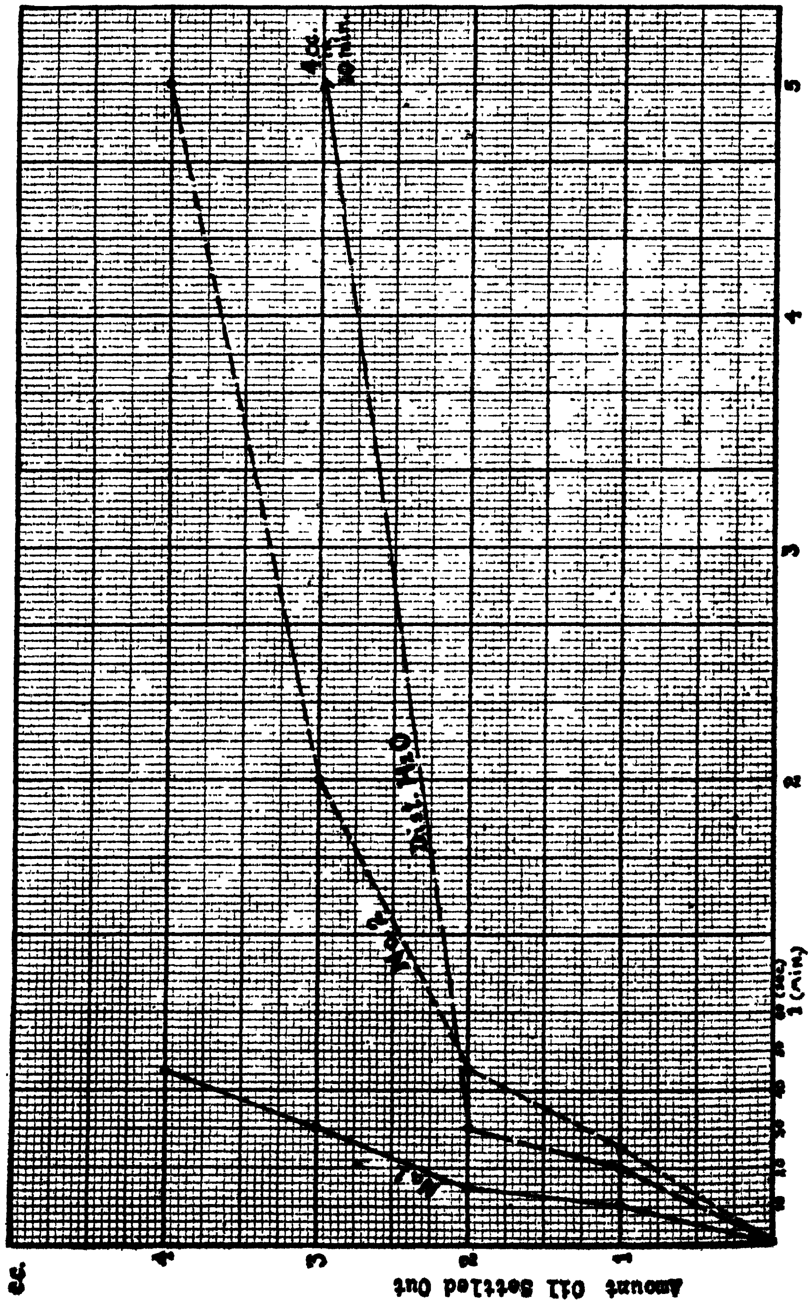

Fig. 46.—Demulsibility curves of two samples of hard water compared with distilled water.

index to the stability of the emulsion. The rate of settling out expressed in cc. per 60 seconds is called demulsibility. This test was modified by using a quantity of the emulsion stock sufficient to separate out four cc. of oil and ninety-six cc. of water and emulsifier, or in other words, the equivalent of a four per cent emulsion. Readings were made at room temperature (70°F.), and a small quantity of an oil soluble dye, Sudan III, was added to facilitate the readings.

The average rate of settling out of each cc. of a four per cent oil emulsion in distilled water using the "cold mix" formula was found to be fairly constant as shown in Table 1 and was used as a constant for comparing the rate of separation in similarly made stocks when diluted with different samples of hard waters.

TABLE 1

Time Since Stopping Paddle	Reading at Interface Between Oil and Water	cc. Oil Settled Out	Rate of Settling in cc. per hour
0	100	0	0
20 sec.	99	1	180
30 sec.	98	2	240
5 min.	97	3	56
10 min.	96	4	24

This method was next applied to samples of hard waters which had previously been analyzed by the Chemistry Department of the New Mexico College of Agriculture and Mechanic Arts and of which the amounts of mineral matter such as magnesium sulfate, calcium sulfate, etc., were known. From these tests two samples are selected and tabulated (Table 2) to illustrate the difference in their reaction to the demulsibility test. Water sample No. 1 is medium in the amounts of total minerals and sodium chloride and high in calcium and magnesium sulfates, while sample No. 2 is exceedingly high in total mineral matter, medium in sodium chloride, and low in magnesium sulfate and calcium sulfate.

TABLE 2

Sample No. 1 Parts per 100,000		Time Since Stopping Paddle	Reading at Interface	cc. of Oil Settled Out	Rate of Settling cc. per hour
Total minerals	80	0	100	0	0
NaCl	16.6	10 sec.	99	1	360
$MgSO_4$ & $CaSo_4$	14.0[1]	15 sec.	98	2	480
		30 sec.	97	3	360
		45 sec.	95	5[2]	324.2

Sample No. 2		0	100	0	0
Total minerals	201.5	25 sec.	99	1	144
NaCl	42.2	45 sec.	98	2	160
$MgSO_4$ & $CaSO_4$	8.9[1]	2 min.	97	3	90
		5 min.	96	4	48

[1] Expressed in terms of $CaCO_3$.

[2] Total demulsible material.

These results are also shown in graphic form, (Fig. 46) using the data from Column 3 of the table in comparison with the data of Column 3, Table 1. From these curves it may be seen that the rate of separation in water sample No. 1, which contained a high percentage of calcium sulfate and magnesium sulfate, was more rapid than for No. 2 in which the amounts of these chemicals were much lower, and the rate of separation in No. 2 was somewhat more rapid than that of the check sample where distilled water was used for dilution.

Since these experiments suggested that the presence of magnesium sulfate, calcium sulfate and perhaps sodium chloride in the water as possible causes for the increased rate of settling out of the oil, it was decided to make up and test synthetic hard waters containing varying amounts of these materials. These chemicals, alone or in combination, were added to distilled water in gradually increasing quantities, beginning with amounts comparable with the average minimum occurrence in the natural waters of the Rio Grande Valley and increasing to amounts of their maximum occurrence. It was found that sodium chloride in quantities up to and beyond its maximum occurrence in Rio Grande Valley waters did not increase the rate of separation of the oil from the emulsions. Also it was demonstrated that calcium sulfate at rates greater than its maximum occurrence in natural waters did not increase this rate. When magnesium sulfate was added to distilled water alone, or to water containing the other aforementioned chemicals, in amounts exceeding five parts to 100,000 the rate of separation was noticeably increased. In addition, an insoluble precipitate, possibly calcium sulfate, is formed which separates out with the oil and makes an exact determination of the amount of oil separating out exceedingly difficult. It was found, however, that readings could be made of the rate of separation of this combination of oil and precipitate, to which we refer as the total demulsible material, and that this rate is proportional to the amount of magnesium sulfate present (particularly within the limits of five to ten parts per 100,000). Figure 47 shows the effect in rate of separation when five, six, seven, and ten parts of magnesium sulfate are added to 100,000 parts of distilled water. The irregularity of these curves may be due to the difference in the ratios of the chemicals forming this total demulsible material. Time did not permit exact determination of these factors and more work is needed to clear up this question.

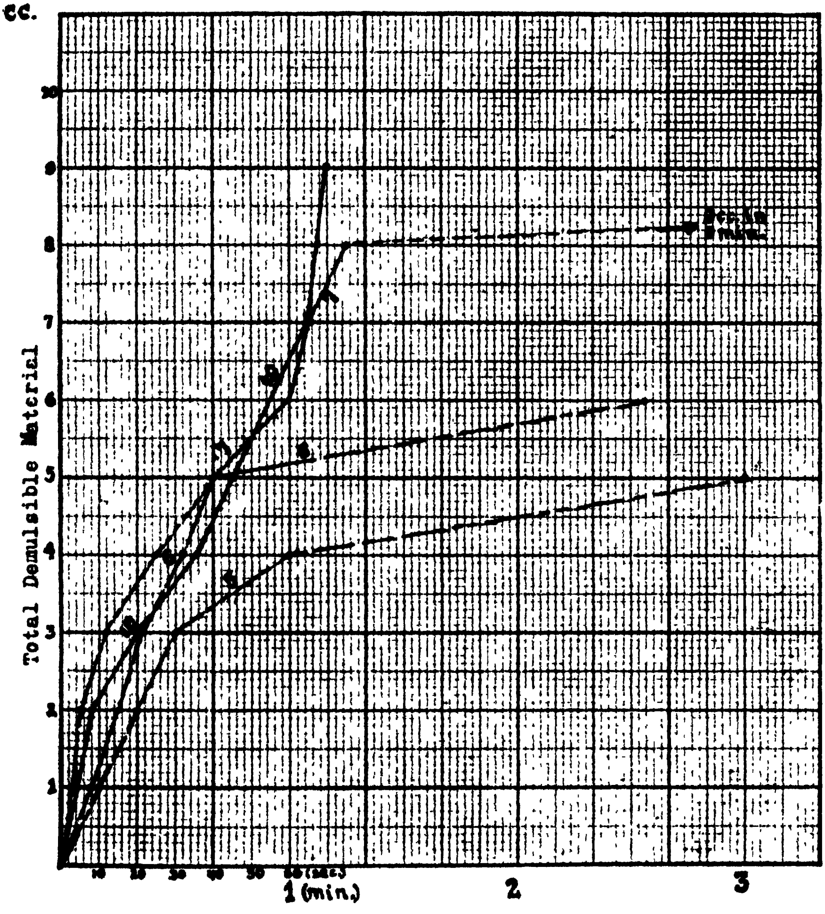

FIG. 47.—Demulsibility curves for waters containing different amounts of magnesium sulfate.

The general tendency of the curves however is for correlation between the amount of magnesium sulfate and the rate of separating out of the oil from the emulsion and the investigation thus far indicates that the presence of magnesium sulfate in waters used for dilution is probably · the principal factor in causing the instability of "cold mix" oil emulsions.

CLIMATIC INFLUENCE ON CITRUS INSECT DISTRIBUTION IN CALIFORNIA

By R. S. Woglum, *Entomologist, California Fruit Growers Exchange*

Abstract

Citrus fruit pests in Califronia occur in more or less well defined areas. Some species are most destructive under the cooler temperatures near the ocean. Other species are destructive only where the summer weather is hot and dry. There are intermediate types. The distribution of these pests in 1927 is compared with that of 1907. An attempt has been made to designate the maximum temperatures and the minimum humidities which appear to limit the destructiveness of the more important citrus pests.

It is a well known fact that the pests of citrus trees in California are limited in distribution to certain more or less well defined areas. This situation was first impressed on the writer in 1907, at which time he spent two or three months in making a careful survey of the citrus insect problem in every locality in southern California. It appeared at the time that climatic differences, particularly that of maximum temperature, were the most positive factors in limiting insect distribution.

Strength to this premise was given by the increasing mortality of black scale then observed as one moved from the coastward districts of Santa Ana and Whittier inland to Pasadena and thence on to Pomona and Riverside. The following quotations are taken from my notes of July and August 1907. "At Santa Ana black scale is everywhere and very bad. Seen in all stages. Practically all eggs under old scales have hatched; almost all scales were empty and very few in which eggs were dried up." At Pasadena, "Under fully one-fourth of the black scales overturned the eggs and larvae were dried up." At Claremont and Upland, "Fully 90 per cent of eggs and young have been killed. Some trees coated with sooty mold fungus show very few young scales alive." At Riverside, "Dried up eggs and young are common hereabouts. Very few young live scale seen, the effect of the hot spell of July being almost complete destruction."

These records indicate that the mortality of black scale during July and August 1907, varied from below 5 per cent at Santa Ana near the ocean to upwards of 99 per cent at Riverside. Weather records show that there occurred about 8 days of real hot weather the last of June and the first of July 1907, the maximum temperature at Riverside being 110 degrees, at Pasadena 103 degrees. No records of Santa Ana's temperature are available but normally it averages 10 to 12 degrees cooler in June and July than Riverside.

Between 1907 and the present time the writer has been in very close touch with citrus insect conditions throughout the State, the greater part of his official time being spent in the orchards rather than in the office or laboratory. This contact has enabled him to observe the status of citrus pests year by year—to note their ups and downs, and any outstanding factors contributing thereto.

Topography of California Citrus Areas

The principal northern citrus areas are in interior valleys separated from the ocean by the Coast Range Mountains and backed by the high Sierras. These valleys are very hot and dry during the summer. The citrus producing lands of southern California extend from Santa Barbara on the north to the Mexican border, with the most inland point, Highland, 60 70 miles from the coast Although tempered to a greater or less extent by ocean influence this southern area is of variable climate, by reason of its topography and varying distance from the coast line. The coastal area in which the orchards are within a few miles of the ocean and subjected to a direct coast influence is comparatively cool. The more interior southern areas which are in valleys shut off from the coast by high hills, while tempered more or less by coast influence, carry decidedly higher summer temperatures and lower humidities than the coastal district.

The Distribution of Citrus Pests in 1907 Compared With 1927

Summing up the distribution of pests in 1927 as compared with 1907, it is a matter of interest to observe that the limits of distribution of the four major pests, the black scale, the red scale, the purple scale and the red spider are very little different to-day than they were 20 years ago. To be sure there has become infested a much greater acreage but this increase is due rather to new plantings within or adjacent the former infested areas rather than to expansion of the pests to new areas. During this 20 years three new major pests have been discovered, the citricola scale, the citrophilus mealybug and the citrus thrips. In this short time all three insects have extended their distribution widely—very probably over the main area which they will henceforth occupy. Their distribution would have been even greater were it not that they appear for the most part to have reached their climatic limitations. The artificial barriers set up by man appear to have had small influence against those of nature.

Relation of Climate to the Distribution of Citrus Pests

The question might be asked: Why do not all these citrus pests occur in equal abundance throughout the entire citrus belt? Our own observations incline us to the conclusion that their distribution is governed primarily by climatic conditions; that while control measures and local quarantines may reduce their numbers or slacken their distribution, it is the factors of high temperatures and of humidity which control the ultimate limits of their establishment.

From the standpoint of climatic adaptation we would classify our California citrus pests into three groups:

1. Those adapted to a mild environment:	Purple Scale Citrophilus Mealybug Common Mealybug
2. Those adapted to a hot dry environment:	Citricola Scale Citrus Thrips Yellow Scale (?)
3. Those adapted to both mild and moderately hot environment:	Black Scale Red Scale Citrus Red Spider Citrus Aphis

The Maximum Temperature Range of California Citrus Areas

We have previously classified the citrus areas into three districts, coastal, southern interior valleys and northern valleys. San Diego has been selected as typifing the extreme coastal condition and Santa Ana the more intermediate coastal condition. Anyone familiar with the climate of the southern interior valleys knows that the summer temperatures increase quite regularly as one proceeds from Los Angeles eastwards to Redlands. We have selected Pasadena as representative of conditions at the coastward end of the interior valleys, Pomona as an intermediate point and Redlands as the extreme interior. Porterville gives the range of the San Joaquin Valley, Oroville, the Sacramento Valley, and El Centro the Imperial Valley.

The comparative range of the summer temperatures of these different districts is well illustrated by the accompanying chart which gives the average hottest day of the month for the 5 year period 1923–1927. An examination of this chart shows that the peak months for extreme temperatures over the citrus areas normally falls during June, July or August; that the maximum temperatures average lowest at San Diego and Santa Ana, highest at El Centro, with Pasadena, Pomona, Redlands, Porterville and Oroville in between. If graphs are based on the mean maximum temperature or the hottest day of the year the comparative positions of the different key stations remain the same as in this chart.

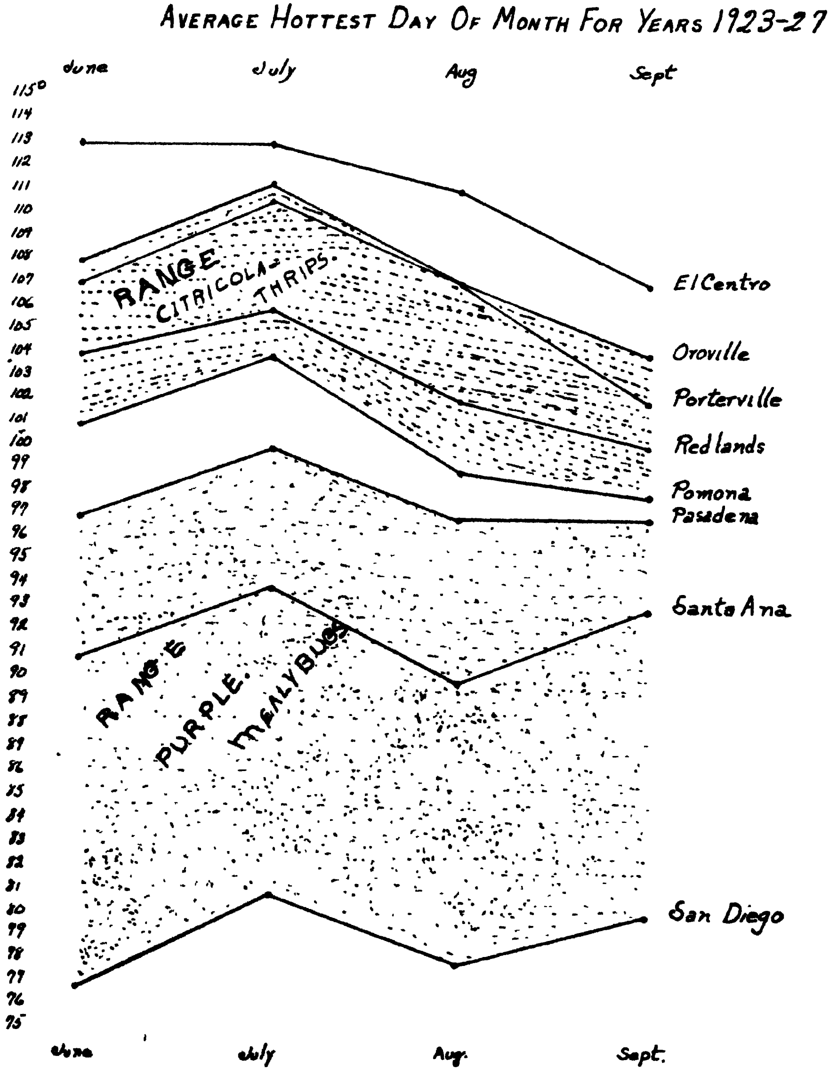

FIG. 48.—Chart showing the peak months for extreme temperatures over citrus areas.

Every summer there occur peak heat waves. Some years the maximum temperature range is not particularly greater than the normal average, but usually there are peak heat waves during which the temperature for a 2 or 3 day period will soar several degrees above the normal. These heat waves are the result of high pressure areas beyond the mountains to the East which force hot dry air over the valleys of southern California until finally dominated by the ocean influence. It has been our observation that these extreme heat waves off the desert combined with the low humidity exerts a major influence on the natural mortality of such insect pests as the black scale and citricola scale. In the Imperial, San Joaquin and Sacramento Valleys the summer climate is normally very dry, and the temperature decidedly more extreme than in the southern citrus belt.

INSECT DISTRIBUTION VERSUS TEMPERATURE RANGE

Returning to our classification of insects based on the temperature range during the summer we find Group I occupying practically the same general limits of distribution to-day as in 1907 (The citrophilus mealybug first appeared in 1912). This range spreads from San Diego where the average hottest day of the year approximates 90 degrees with a mean minimum relative humidity of approximately 74 per cent, to Pasadena with its maximum temperature of the year approximating 103 degrees and a minimum relative humidity for the summer ranging from 18 to 40 per cent. The subject of climatic influences requires too extended a discussion to be entered into fully within the few minutes available for this paper. Only the high points will be mentioned. Obviously the purple scale requires reasonably humid conditions for full development and the influence of temperatures even around 85 to 90 degrees appears reflected in its habit of initial infestation on the interior lower north side of orange trees. The citrophilus mealybug has been known to be destructive outside of the temperature range of Group I but only in cases where associated with the argentine ant. Apparently it is temperature, rather than humidity, which is the main factor in controlling this pest.

In Group II occur such pests as the citricola scale which is a severe pest over the range from Pomona as a minimum (hottest summer day averaging around 106 degrees) to Oroville as a maximum (hottest day around 112.5 degrees). The humidity of Pomona (unrecorded) would be slightly less than that for Pasadena (minimum range in summer 18 to 40 per cent). The humidity of Oroville is unrecorded but the summer minimum probably approximates that of other northern interior valley points, as Fresno which averages below 20 per cent. That extreme temperatures with low humidities are particularly destructive to citricola scale was shown by the effect of a heat wave at Redlands in 1925 when the temperature reached 114 degrees with a humidity of 12 per cent; another case occurred in 1926 in Tulare County when the temperature reached 114 degrees and reduced citricola scale to commercial control over the entire county; still another was the heat wave of June 1917 in southern California when its maximum of 118 or 119 degrees almost eradicated this pest. At Oroville temperatures 2 or 3 degrees above 112 are recorded practically every other year. Here the citricola scale is generally distributed but is not a commercial pest as at Porterville. Infestations of this pest in Los Angeles and Orange Counties where the average maximum temperatures are below 100 degrees and the humidity somewhat higher than at Redlands have disappeared. Apparently the young citricola scale is severely affected by high humidity as well as by extremes of temperature.

The citrus thrips appear not to become a pest where the humidity is higher and the temperature lower than that of Pomona. Citrus thrips appear adapted to arid conditions only, being most damaging in the northern valleys where the summer humidity averages below 20 per cent, some months below 15 per cent and the maximum temperature reaches 111 degrees or above. It also occurs in the Imperial Valley with an average maximum temperature of 114 degrees. The fact that the thrips is present but not damaging in Los Angeles or Orange Counties indicates humidity to be the main controlling factor to its abundance.

Yellow scale is of rather uncertain limitations. It thrives best in the Highland-Redlands area with its maximum summer temperature of 108 degrees. Its presence in severe infestations in northern California cities but only to a limited extent in the orchards shows it is able to maintain itself even where maximum summer temperatures reach 111 or 112 degrees. On the other hand this scale is occasionally moderately damaging under the climatic conditions of the coastal area.

Group III: The black scale thrives under the low summer temperatures and high relative humidity as typified by San Diego conditions, also is a severe pest under the climatic complex of Pomona. The maximum temperature which limits it as a pest is represented by Redlands with its maximum of 108 degrees. The black scale mortality apparently is influenced by very low humidities and comparatively high temperatures. Very close distinction is not obtainable without further study.

Susceptibility to high temperature varies with the stage of the insect. The eggs and the young larvae of black scale are particularly susceptible to high temperature and dryness while under the old shell. Temperatures above 104 or 105 degrees at this period are very destructive when the humidity is low. The larvae of the first and second stages on leaves have been known to be largely destroyed at temperatures above 106 degrees particularly where the humidity was low. When the humidity goes below 15 such temperatures if maintained for a prolonged period are destructive even to comparatively large scale.

The red scale also is an insect adaptable to variable climatic conditions. Like the black scale it thrives under San Diego conditions; it is also a pest on lemons under the climatic conditions of Pomona. Red scale is not a pest under the temperature and humidity of Riverside and Redlands. However, at Corona, with maximum temperatures practically identical with those of Redlands, red scale is a pest. Indications are that a greater humidity at Corona might be the controlling factor. Furthermore, supporting evidence in this direction would appear in the case of the citricola scale, an insect adversely influenced by high humidity and which is far less severe at Corona than at Redlands.

Summing up our thoughts in this paper in a tentative way as based on present information and subject to modification as complete evidence is collected, the following table is given:

Pest	Approximate Summer Temperatures Limiting the Distribution of Citrus Pests, as Based on the Average Hottest Day for the Five Year Period, 1923–1927.
Purple Scale	Not Damaging above 103 Deg. with Min. Hum. 18 to 40%[1]
Common Mealybug	" " " 104 " " " " " " "
Citrophilus Mealybug	" " " 104 " " " " " " "
Black Scale	" " " 108 " ———
Citricola Scale	" " " 113 " Min. Humidity 10 to 15% " " below 104 " Min. Humidity?
Red Spider	" " above 108 " ———
Citrus Thrips	Damaging at the Highest Temperatures of Citrus Belt, 113 Degrees. Minimum Humidity 15 to 20%. Not Damaging in Districts with Maximum Temperature below 105 degrees. Humidity?

[1] Range of minimum relative humidity during summer.

An attempt has been made in this paper to show that once citrus pests were firmly established in California their ultimate distribution has been controlled by climatic conditions, mainly temperature and humidity; not by the attempts of man to limit their distribution. The fact that few records of humidity are available has made the problem both difficult and incomplete. It is hoped that with more complete records which will ultimately be obtained more clear determinations can be drawn. Such records should be of particular value from the standpoint of local quarantines. At the present time little distinction is made as between a pest destined for a district of high summer temperature or low summer temperature; whether humid or arid. The freedom of the locality from infestation is the main consideration. Not that the pest might or might not be able to live there. Insects are adapted to certain environments. If we are to establish quarantines on the basis of scientific analysis why should not cognizance be taken of the factor of environment, if definitely known?

STUDIES ON THE RESISTANCE OF CERTAIN INSECTS TO HYDROCYANIC ACID

By A. M. BOYCE, *Univ. of Calif., Citrus Exp. Station, Riverside, Calif.*

ABSTRACT

Instances of resistance or increased tolerance of insects to insecticidal treatment are briefly reviewed. A study is being made of the development of resistance to HCN gas of several species of insects. The results of fumigation experiments with *Drosophila melanogaster* Meig. and *Aphis gossypii* Glover are presented.

The problem of the development of resistance or increased tolerance of insects to insecticidal treatments is at present confronting economic entomologists for possible solution. So marked in degree has this problem become in some instances that it has caused a change in the pest control programs and this change has not effected altogether satisfactory results.

In 1914 Melander[1] reported that the San José scale was apparently becoming resistant to the sulfur-lime sprays that had heretofore given a satisfactory kill.

Coincident with Melander's observations, in the Corona section of Southern California it was noted that fumigation with HCN gas for the red scale, *Chrysomphalus aurantii* Mask., of citrus trees was not giving the high percentage of kill that was formerly secured under similar conditions. Quayle[2] at first thought that this was due to some defect in the fumigation procedure but further investigation showed that there was a much greater survival of the scale from Corona than of the scale from other sections when they were fumigated under identical conditions. Woglum[3] reported similar findings after making a series of tests with the red scale. The area of resistant red scale now includes Corona, North Whittier Heights, Whittier and a considerable part of the citrus sections of Orange County.

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[1] Melander, A. L. Can Insects Become Resistant to Sprays? Jour. Econ. Ent. 7: 167-172, 1914.

[2] Quayle, H. J. Are Scales Becoming Resistant to Fumigation? Jour. Agr. U. of Cal. 3:333, 1916.

Poor results from fumigation against the black scale, *Saissetia oleae* Bern., were first noted in the Charter Oak section of California in 1912. Subsequently, the area in which increasingly poorer results were obtained with HCN gas fumigation has grown until it now includes most of the area between Alhambra and Cucamonga or the eastern part of Los Angeles County and the western part of San Bernardino County.

Further evidence that a marked variation in relative resistance may exist with insects of the same species to insecticidal treatment is brought out in the recent work of Hough[4] of the Va. Agr. Exp. Sta. In testing the relative ability of larvae of the codling moth from two different localities to enter apples sprayed with arsenate of lead, Hough found that the Colorado codling moth larvae with which he worked were more resistant to arsenical poisoning than were those of the Shenandoah Valley of Virginia.

Since it has become to be quite generally accepted that some insects, particularly the species of Coccids already referred to, have developed a marked degree of resistance to HCN gas it is of interest to postulate on how this has come about. Is it merely a case of selecting artificially through continued fumigation the most vigorous individuals, and that they then transmit to a portion of their progeny this ability to resist certain concentrations of HCN gas? But does this satisfactorily explain the situation? Why then have not these species of scales developed a resistant strain in all sections where fumigation has been employed? With the red scale for instance the areas in which the resistant strain occurs are more or less spotted. There are sections where HCN gas has been employed over as long a period, or possibly longer than in the resistant sections and in which the kill obtained is entirely satisfactory. With the black scale the resistant area is continuous, or at least more so than is the case of the resistant red scale. To further complicate an understanding of the situation an occasional grove in the center of a resistant red or black scale area is kept commercially clean through fumigation with a normal dosage of gas. This feature is difficult to explain under the theories of possible development of resistance.

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[3] Woglum, R. S. Observations on Insects Developing Immunity to Insecticides. Jour. Econ. Ent. 18:593–597. 1925.

[4] Hough, W. S. Relative Resistance to Arsenical Poisoning of Two Codling Moth Strains. Jour. Econ. Ent. 21:325–329, 1928.

Another possibility of interest in this connection is the theory of the introduction into these particular areas of more vigorous strains or races of the species. It is not improbable that very hearty scales coming from various and different parts of the world may have become mixed with the race of the same species in the areas where a resistant strain has now developed. However, our theories must remain as mere hypotheses until some evidence has been accumulated which will show the nature of this resistance.

The following experimental work dealing with a study of this problem is being carried on at the Citrus Experiment Station. The aim of the work reported upon in this paper is to attempt to produce through continued artificial selection a strain of insects more resistant to HCN gas than were the original parents.

In a study of this nature it is advantageous to select species of insects that are naturally adapted to meet certain desired conditions. The vinegar or pomace fly, *Drosophila melanogaster* Meig., was chosen for use in one of the experiments These flies are relatively easily handled in the laboratory and are reared on artificial media; they are also prolific and rapid breeders. They reproduce sexually, and the sexes are readily distinguishable with the unaided eye. This feature is of value because of the possibility of resistance to HCN gas being heritable according to Mendelian laws in which case it might be sex-linked in its transmission. And a further advantage is the fact that these flies are naturally very susceptible to HCN gas.

In the beginning it was necessary to determine by a series of trials the dosage of gas that would consistently kill a high percentage of the flies fumigated. A practically gas tight fumigatorium of 100 cu. ft. capacity is being used for these fumigation experiments, since a unit of this size greatly reduces the error in the concentration of gas over a smaller unit such as a bell jar of say .5 cu. ft. capacity. The standard amount of liquid HCN used in these tests is 2.5 cc. and the exposure is 45 minutes. These criteria were determined from data obtained from a series of trials, using flies that were reared in the laboratory under more or less standard conditions of temperature, food, etc. The general procedure then, is to rear a population of flies and fumigate them under conditions as stated above. All of the flies are stupefied when removed from the fumigatorium. After 12 to 15 hours the flies that survive are counted, and the number of each sex is noted. Those flies that succumb to the gas are also counted, the sexes separately in order to obtain the sex ratio of the entire population. Cultures of those individuals surviving each treatment are set up for reproduction. The flies of each filial generation are fumigated together with a check of stock flies that are reared under like conditions.

To date seven generations have been reared and fumigated. The results obtained are summarized as follows:

SUMMARY OF DROSOPHILA FUMIGATION EXPERIMENTS

Pedigree	Total No. Flies	No. Flies Surviving	Per cent Surviving	Per cent above Check Surviving
Original parents	7941	152	1.8	——
F-1	7345	428	5.8	2.1
CHECK	19154	697	3.7	——
F-2	8163	286	3.5	1.5
CHECK	11515	247	2.0	——
F-3	4474	83	1.8	.3
CHECK	5157	62	1.5	——
F-4	1646	123	7.4	6.8
CHECK	2840	17	.6	——
F-5	1288	182	14.1	12.2
CHECK	1952	37	1.9	——
F-6	5543	183	3.3	1.8
CHECK	2327	37	1.5	——
F-7	7001	292	4.1	2.7
CHECK	2450	36	1.4	——
Totals F-1 to F-7 inclusive	35460	1577	4.4	2.
CHECKS	45395	1133	2.4	——

From the above data there is an indication of slight development of resistance in the populations of flies bred from parents that survived the standard dosage of HCN gas to which they were subjected. Thus far the tests have not shown that through continued selection an increasing degree of resistance develops.

Another species of insects chosen to work with in connection with this study was the cotton or melon aphid, *Aphis gossypii* Glover. These aphids are propagated on potato sprouts in cages in the insectary. They breed very rapidly and are quite susceptible to HCN gas. When propagated indoors under controlled temperatures the insects reproduce parthenogenetically entirely. This feature is somewhat comparable with the reproduction of the black scale, though not wholly so for males of the black scale have been observed in most of the citrus sections. However, the part that these males play in the reproduction of the species is not fully understood but it is generally assumed that most of the black scale are produced parthenogenetically.

In this work as with the Drosophila it was necessary to determine the dosage and exposure that would consistently kill the greater percentage of the aphids. The standard found to be satisfactory was 3cc. of liquid HCN in a 100 cu. ft. fumigatorium with an exposure of 30 minutes.

By trials with several systems of growing potato sprouts on which to rear the aphids, it was found that a single bushy plant in a 4 inch flower pot served the purpose best. The potato plants on which the aphids are feeding are put into the fumigatorium and the pots bearing them are placed on large sheets of light paper. In this way the aphids that fall off are readily observed and counted. With each pedigreed batch of aphids fumigated, plants which bear aphids that have never been exposed to HCN gas are included in the test to serve as a check.

The results of the experiments to date are summarized as follows:

SUMMARY OF APHID FUMIGATION EXPERIMENTS

No. of Successive Fumigations	Total No. Aphids	No. Aphids Surviving	Per cent Surviving	*Check* Per cent Surviving	Per cent above (+) or below (—) Check Surviving
1st fumigation	12430	453	3.6	—	—
2nd fumigation	12106	594	4.9	2.1	+ 2.8
3rd fumigation	5985	86	1.4	2.7	— 1.3
4th fumigation	3043	185	6.0	3.3	+ 2.7
5th fumigation	3160	230	7.2	4.4	+ 2.8
6th fumigation	2541	151	5.8	3.7	+ 4.6
7th fumigation	1698	348	20.5	3.3	+17.2
Totals.	40963	2047	Av. 7.6	3.2	+ 4.4

NOTE: After several months of success in propagating the aphids in large numbers the work was held up due to the mortality caused by an Aphelinus parasite which nearly wiped out the breeding stock in most of the cages.

The data presented above tends to indicate that a slight degree of resistance is manifest through selection with the exception of the population that made up the third fumigation test. In this instance a larger percentage of the check survived than of the pedigreed strain which fact clearly indicates that variable factors are involved in making a study of this nature.

Other species of insects that are used in connection with this study are the granary weevil, *Sitophilus granarius* Linn., the confused flour beetle, *Tribolium confusum* Jack. Duv., the saw-toothed grain beetle, *Oryzaephilus surinamensis* Linn., and the red and black scales. The three species of beetles mentioned breed very readily in the laboratory in grains and grain products and are fairly easily handled. The granary weevil is naturally resistant to HCN gas requiring approximately six times the concentration of gas with a much longer exposure than that which is required to kill the other two species.

The fumigation of these beetles is done in bell jars of .5 cu. ft. capacity which are sealed to plate glass with vaseline. The liquid HCN is atomized and introduced through an opening in the plate glass. To date these tests have not been carried far enough to have sufficient data to present at this time.

The work with the red and black scales is along similar lines to that already outlined. The red scales are propagated on lemon seedlings and on small navel orange trees. The black scales are propagated on seedling and also on small navel orange trees. For the red scale tests one-half of the trees used are infested with progeny from known resistant areas and the remainder are infested with progeny from known non-resistant areas. This system is likewise being used in the black-scale studies. All of the trees are growing in large pots in insect-proof rooms which are built in a separate lath house. The resistant strains of insects are kept isolated from the non-resistant strains. Thus far no data have been secured from this experiment.

It is to be understood that this paper is merely a progress report and is presented at this time with the hope of invoking criticism and suggestions as an aid in continuing the work.

THE EFFECT OF DIFFERENT QUANTITIES OF FOOD DURING THE LARVAL PERIOD ON THE SEX RATIO AND SIZE OF *LUCILIA SERICATA* MEIGEN AND *THEOBALDIA INCIDENS* (THOM.)

By W. B. Herms, *University of California*

Abstract

Larvae of the green bottle fly, *Lucilia sericata*, were removed from food in lots of one hundred at six-hour intervals after feeding thirty hours, the longest feeding period being 96 hours. The size of resulting flies became in general increasingly larger as the feeding period was increased and the sex ratio was reversed from a large preponderance of males in the underfed to a preponderance of females in the longer feeding periods. Larvae of the mosquito, *Theobaldia incidens*, were reared in lots of one hundred in distilled water to which yeast was added in quantities ranging from .5 gram to 5 grams. The resulting mosquitoes became in general increasingly larger

as the quantity of yeast was increased and the sex ratio was reversed in a manner opposite to that of the green bottle fly.

A number of years ago while investigating the growth of flesh flies, particularly *Lucilia caesar* Linn., a series of experiments on underfeeding was conducted by the writer.[1] Although at the time no record was made of the fact, it was observed that a complete reversal of the sex ratio occurred in the flies resulting from underfed larvae, i.e., there was a marked preponderance of females when the larvae were permitted to feed until they left the food of their own accord, after about 72 hours' feeding, while a preponderance of males resulted from the larvae which were removed from their food at 36 to 42 hours' feeding. The effect of underfeeding on the size of the flies is, of course, a matter of common observation, but is nevertheless well illustrated in a figure shown in the publication above cited. The effect of undernourishment on the size of individuals of a given species is referred to by Wheeler,[2] Social Life Among the Insects (p. 160, Ants and their habits), viz: "It is obvious that some of the differences between the various castes, especially those in size, are due to differences in the amount of food consumed during the larval stages, but the profounder morphological differences which separate the queens, soldiers and workers, must be due to other causes."

In the consideration of sex ratio as affected by underfeeding, the writer in this present paper obviously does not claim for underfeeding any more profound influence than that of survival, i.e., it would appear from the evidence that for certain flies at least the larval females require a larger amount of nourishment than the males, hence fewer females survive in the shorter feeding periods. For the mosquito, *Theobaldia incidens* the reverse situation appears to exist.

The normal sex ratio of species shows wide variation, although the ratio within a given species under optimum feeding conditions is fairly stable. For *Musca domestica* Linn., the ratio is very nearly 1:1; for *Ornithodorus moubata* Murray it is also about 1:1 according to Jobling,[3] while according to Hargreaves[4] the ratio for the coffee-berry borer (*Stephanoderes hampei* Ferr.) is 10:1, i.e. ten females to one male.

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[1] Herms, W. B. An ecological and experimental study of Sarcophagidae with relation to lake beach debris. Jr. Exp. Zool. vol. IV, No. 1, pp. 45–83. 1907.

[2] Wheeler, W. M. Social Life Among the Insects. Harcourt, Brace and Company, New York. 1923.

[3] Jobling, B. A contribution to the biology of *Ornithodorus moubata* Murray. Bul. Entom. Res. vol. XV, Pt. 3, pp. 271–279. 1924–25.

[4] Hargreaves, H. Notes on the coffee berry-borer (*Stephanoderes hampei* Ferr.) in Uganda. Bul. Entom. Res. vol. XVI, Pt. 4, pp. 347–354. 1926.

EXPERIMENTS WITH *Lucilia sericata* SEX RATIO

Adult flies of *Lucilia sericata* were collected out-of-doors and placed in cages where masses of eggs were deposited either on fish or beef lung. Clumps of eggs deposited at approximately the same time were then transferred to a receptacle with a new piece of beef lung. The time of hatching was carefully observed, then after 30 hours of feeding one hundred larvae were removed and placed in a jar of clean sand for further observation. Thereafter, every six hours another hundred larvae were removed and treated in the same manner until the remaining larvae migrated from the food of their own accord, i.e., after approximately 96 hours of feeding. All of the jars containing the fed larvae were kept in a warm chamber at 80° ± 2° F. It is of interest to note that the pupal period at this temperature ranged from four days for the shortest fed larvae to seven days for the migrated individuals, with pupation taking place in all cases at approximately the same time.

The following table (Table 1) shows the results of the first series thus treated.

TABLE 1, SERIES 1. SHOWING THE EFFECT OF LARVAL FEEDING ON THE SEX RATIO OF *Lucilia sericata*. EGGS LAID MAY 5, 1928. HATCHED SAME DAY. FIRST LARVAE REMOVED MAY 7, 1928, 12 O'CLOCK MIDNIGHT

Feeding Period	Pupal Period	Number of Flies Males	Number of Flies Females	Total	Sex Ratio Males	Sex Ratio Females
30 hrs.....	4 days	20	11	31	6.5	3.5
36 hrs.....	4 days	22	24	46	4.8	5.2
42 hrs.....	5 days	59	43	102	5.8	4.2
48 hrs.....	5 days	43	40	83	5.2	4.8
54 hrs.....	5 days	45	58	103	4.3	5.7
60 hrs.....	5 days	49	51	100	4.9	5.1
66 hrs.....	5 days	49	50	99	5.0	5.0
72 hrs.....	6 days	51	52	103	5.0	5.0
78 hrs.....	6 days	55	52	107	5.1	4.9
84 hrs.....	6 days	62	38	100	6.2	3.8
90 hrs.....	7 days	38	60	98	3.9	6.1
96 hrs.....	7 days	31	78	109	2.8	7.2

It will be observed that Table 1 indicates an error in the number of larvae taken from the food at the various intervals and also a probable discrepancy in the sex ratio for the 84-hour feeding period as indicated by the results of Series 2, Table 2.

TABLE 2, SERIES 2. SHOWING THE EFFECT OF LARVAL FEEDING ON THE SEX RATIO OF *Lucilia sericata*. EGGS LAID JUNE 20, 1928. HATCHED JUNE 22, 1928. FIRST LARVAE REMOVED JUNE 23, 6 P.M.

Feeding Period	Pupal Period	Number of Flies			Sex Ratio	
		Males	Females	Total	Males	Females
36 hrs.....	Dead	—	—	—	—	—
42 hrs.....	4 days	43	26	69	6.2	3.8
48 hrs.....	4 days	28	21	49	5.7	4.3
54 hrs.....	5 days	59	38	97	6.0	4.0
60 hrs.....	6 days	53	44	97	5.5	4.5
66 hrs.....	6 days	47	49	96	4.9	5.1
72 hrs.....	6 days	45	53	98	4.6	5.4
78 hrs.....	6 days	43	54	97	4.4	5.6
84 hrs.....	6 days	26	40	66	3.1	6.9
90 hrs.....	6 days	32	48	80	4.0	6.0
96 hrs.....	7 days	30	66	96	3.1	6.9

The above tables (Tables 1 and 2) show a fairly steady reversal of the sex ratio from 2.8:7.2 (males to females) for flies resulting from larvae which fed until they left the food voluntarily, to a ratio of 3.5:6.5 (males and females) for the flies resulting from larvae which fed only thirty hours, the shortest time that resulted in a completion of the life history. The exception (possibly an error) already referred to is in the 84-hour feeding period in Table 1. Cooler conditions existing during the feeding period at the beginning of Series 2 (Table 2), thus retarding growth, account for the absence of flies until the 42-hour feeding period is reached.

SIZE OF FLIES

As already stated, the size of the winged insect (the fly) is greatly affected by the amount of food which the larva is permitted to consume, i.e., cutting down the larval food supply reduces the size of the fly. A convenient basis for the measurement of size appears to be in the length of the wing. These measurements were made under the microscope by aid of the micrometer scale attached to the moveable stage. The length of the wing is taken from the region of the notch between the anti-squama and the alula to the very tip of the wing.

From Table 3 it will be seen that the wing length of the males varied from 4.3 mm. for those resulting from a 42-hour larval feeding period, to 5.3 mm. for those with a larval feeding period of 72 hours, while the wing length of females for the same larval feeding periods was 4.2 mm. and 5.9 mm. respectively. For the flies having larval feeding periods of more than 78 hours, there appears to be a tendency toward reduction in size. It is worthy of note that the shortest length of time

TABLE 3. SHOWING VARIATION IN WING LENGTH OF INDIVIDUAL FLIES (*Lucilia sericata*) AS AFFECTED BY LARVAL FEEDING. MEASUREMENTS ARE IN MILLIMETERS

Larval feeding period		Length of Wing of Fly in Millimeters																																					
		3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	6.6	6.7	Aver. ♂	Aver. ♀	Aver. ♂ & ♀
42 hrs.	♂	4	1	1	6	–	3	1	7	–	2	–	4	–	2	1	2	–	1	–	–	–	1	2	1	1	–	–	3	–	–	–	–	–	–	–	4.3	4.2	
	♀	–	1	–	3	–	–	2	6	2	4	–	1	–	1	–	–	2	1	1	–	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–			4.2
48 hrs.	♂	–	–	–	1	–	1	1	–	–	–	–	–	–	–	1	3	2	10	4	4	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	4.8	4.9	
	♀	–	–	1	–	1	1	–	–	–	–	–	2	–	1	–	–	–	4	1	3	2	2	–	2	–	–	–	–	–	–	–	1	–	–	–			4.8
54 hrs.	♂	–	–	–	–	–	–	–	–	–	1	2	1	–	1	2	2	4	11	3	2	–	6	3	3	5	1	1	1	–	1	1	2	3	2	1	5.3	5.5	
	♀	–	–	–	–	–	–	–	1	–	–	1	1	–	2	–	2	1	1	1	2	2	2	–	–	1	3	4	6	2	2	–	1	–	2	1			5.4
60 hrs.	♂	–	–	–	–	1	–	–	–	1	–	3	1	1	1	–	1	1	3	5	7	13	7	3	4	1	–	–	–	–	–	–	–	–	–	–	5.1	5.6	
	♀	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	2	–	–	–	–	–	3	5	12	8	5	1	5	–	–	–	–	–	–	2			5.3
66 hrs.	♂	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	2	5	3	4	11	8	9	–	1	–	–	–	–	–	–	–	–	–	–	5.2	5.6	
	♀	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	4	4	6	9	9	10	4	2	–	–	–	–	–	–	–			5.4
72 hrs.	♂	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	10	4	4	5	7	11	3	1	–	–	–	–	–	–	–	–	–	–	5.3	5.9	
	♀	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	3	3	6	13	21	4	–	1	–	–	–	–			5.6
78 hrs.	♂	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	2	4	3	4	5	7	4	6	6	1	–	–	–	–	–	–	–	–	–	5.3	5.9	
	♀	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	4	6	5	3	3	15	7	6	2	1	–	–	–			5.6
84 hrs.	♂	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1	2	1	–	5	4	1	4	2	5	–	–	–	–	–	–	–	–	–	–	5.3	5.8	
	♀	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	5	2	5	3	12	6	2	1	–	–	–	–			5.6
90 hrs.	♂	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	6	7	10	2	4	1	–	–	–	–	–	–	–	–	–	–	–	5.2	5.7	
	♀	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	7	11	11	13	3	3	–	–	–	–	–	–	–			5.5
96 hrs.	♂.	–	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	1	9	6	6	2	2	2	–	–	–	–	–	–	–	–	–	–	–	–	5.1	5.6	
	♀	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	2	3	7	9	17	7	5	3	5	2	2	2	1	–	–	–			5.4

the flies remained in the pupa was from four days for those having the shortest larval feeding periods and increased to seven days for those having the longest larval feeding periods. (See Tables 2 and 3.) The entire life history (shortest totals from egg deposition to emergence of fly) required eleven days.

EXPERIMENTS WITH *Theobaldia incidens:* SEX RATIO AND SIZE OF MOSQUITOES

It is a matter of common observation that for at least many species male mosquitoes are the first to emerge from the pupa. This was observed for *Theobaldia incidens* in these experiments as well as in others to be reported at another time. While experimenting with yeast as a suitable food for rearing mosquitoes under known conditions, it was found that the size of these insects was influenced in a marked degree, i.e. smaller quantities of yeast produced smaller individual mosquitoes. For the purpose of these experiments battery jars were used, all thoroughly autoclaved and covered with sheets of sterile cotton between bobbinet. Into each jar was placed a litre of distilled water the pH of which was 6.4 to 6.6. Egg rafts of a previous night's laying were placed in jars of distilled water, usually from six to eight rafts being used for each series. The newly hatched larvae were then thoroughly mixed, and from this mass of larvae lots of 75 to 100 were counted out and transferred to the battery jars, which had been provided previously with Fleischmann's yeast in quantities varying from 0.5 gram to 5 grams. Daily readings were made of the hydrogen ion concentration.

Table 4 gives a summary of the results of a preliminary experiment with regard to the use of various quantities of yeast as food. The larvae used in this experiment were all from one egg raft deposited by one female mosquito.

With at least an indication of reversal in the sex ratio, although quite the opposite from *Lucilia sericata,* further investigation seemed of interest. Therefore, early the following year, when eggs again became readily available, other series were planned. The first of the 1928 results are summarized in Table 5.

The entire life history (shortest time for each stage) required 21 days and that with 5 grams of yeast; for 4 grams it required 24 days; for 3 grams, 25 days; for 2.5 grams, 31 days; for 2 grams, 35 days; for 1.5 grams 41 days; for 1 gram 66 days; and for 0.5 gram, 56 days. Larvae in distilled water without yeast were all dead at the end of 7 days.

Table 4. Showing Sex Ratio in *Theobaldia incidens* the Larvae of which were fed on Fleischmann's Yeast in Quantities as Indicated. Battery Jars with One Litre of Distilled Water were Used. This was a Preliminary Test Begun June 26, 1927 and ended July 23, 1927. The Average Temperature of the Laboratory for this Period was about 73° F.

Quantity of yeast	pH at start	pH at End	pH Range	To first Pupa	To first Emergence	Number Emerging	Per cent Emerging	Males	Females	Sex Ratio Males	Sex Ratio Females
None	6.6	—	—	—	—	—	—	—	—	—	—
0.5 gram	6.6	6.9	6.4–7.0	18 ds.	27 ds.	1	1.3	1	0	—	—
1.0 gram	6.6	7.1	6.4–7.2	17 ds.	22 ds.	13	17.3	7	6	5.4	4.6
1.5 grams	6.6	7.0	6.4–7.2	16 ds.	20 ds.	54	72.0	22	32	4.1	5.9
2.0 grams	6.6	7.4	6.5–7.4	15 ds.	19 ds.	72	96.0	37	35	5.1	4.9
4.0 grams	6.6	5.7	5.4–6.6	13 ds.	18 ds.	58	77.3	31	27	5.3	4.7

Table 5. Showing Sex Ratio in *Theobaldia incidens*, the Larvae of which were fed on Fleischmann's Yeast in Quantitie Ranging from .5 Gram to 5 Grams per Litre of Distilled Water, 100 Larvae per Jar. Experiment begun February 14, 1928, Ended April 17, 1928. Average Maximum Temperature 74.3° F.; Average Minimum 66.5° F.; Average Temperature 70.3° F.

Quantity of Yeast	pH at Start	pH at End	pH Range	To First Pupa	To First Emergence	Number Emerging	Per cent Emerging			Sex Ratio	
							Total	Males	Females	Males	Females
None	6.6	6.6	6.6–6.8	dead	—	0	0	—	—	—	—
.5 gram	6.6	7.0	6.4–7.0	19 ds.	22 ds.	3	3	3	—	—	—
1.0 gram	6.6	7.0	6.6–7.4	17 ds.	21 ds.	9	9	3	6	3.3	6.7
1.5 grams	6.6	7.2	6.6–7.4	16 ds.	19 ds.	67	67	32	35	4.8	5.2
2.0 grams	6.6	7.2	6.4–7.4	16 ds.	20 ds.	63	63	24	39	3.8	6.2
2.5 grams	6.6	7.4	6.4–7.4	15 ds.	18 ds.	88	88	45	43	5.1	4.9
3.0 grams	6.6	7.6	6.4–7.6	15 ds.	18 ds.	18	18	14	4	7.8	2.2
4.0 grams	6.6	7.4	6.2–7.4	14 ds.	18 ds.	31	31	17	14	5.5	4.5
5.0 grams	6.6	7.2	5.8–7.2	14 ds.	19 ds.	7	7	3	4	4.3	5.7

TABLE 6. SHOWING VARIATION IN WING LENGTH OF INDIVIDUAL MOSQUITOES (*Theobaldia incidens*) THE LARVAE OF WHICH WERE FED ON DIFFERENT QUANTITIES OF YEAST AS INDICATED. WING LENGTHS ARE IN MILLIMETERS

Length of wings in mm.	Amount of Yeast							
	0.5 gram	1.0 grams	1.5 grams	2.0 grams	2.5 grams	3.0 grams	4.0 grams	5.0 grams
3.5	—	1	—	—	—	—	—	—
3.6	—	2	—	1	—	—	—	—
3.7	1	2	—	—	1	—	—	—
3.8	1	4	1	4	—	2	—	—
3.9	1	1	—	6	—	—	—	—
4.0	—	12	2	6	4	—	—	—
4.1	—	5	—	9	4	—	—	—
4.2	2	11	7	4	4	1	—	1
4.3	—	5	4	5	7	1	3	—
4.4	1	3	3	10	9	4	5	—
4.5	—	3	5	9	22	8	5	1
4.6	—	—	3	4	7	5	5	—
4.7	—	1	—	2	8	13	4	2
4.8	—	—	3	2	2	7	4	1
4.9	—	1	1	—	—	5	2	—
5.0	—	1	1	—	1	10	2	1
5.1	—	—	2	—	—	5	—	—
5.2	—	—	—	—	—	1	—	—
Totals	6	52	32	62	69	62	30	6
Aver. length of wing in mm.	4.0	4.1	4.4	4.2	4.4	4.7	4.6	4.6

SIZE OF MOSQUITOES

In the flies already discussed a reduction in the quantity of food resulted in a reduction in the size of the winged insect. The quantity of food available to mosquito wrigglers appears to have a similar effect. As a matter of fact, these observations relative to sex ratio and size in mosquitoes grew out of our desire to find the optimum quantity of yeast which might be used as food for the larvae. It will be seen from Table 6 that although larger mosquitoes resulted from the larger quantities of yeast used as larval food, there was a decided reduction in the number of mosquitoes bred under such conditions. Wing length is taken as a basis for size comparisons, the measurements for length being taken from the notch between the alula and the inferior costal margin to the tip between the 2d and 3d long veins.[5]

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[5] The writer gratefully acknowledges the assistance of O. H. Lovell, R. E. Barrett and A. E. Michelbacher.

SUMMARY

1. Lots of flies (*Lucilia sericata*) resulting from larvae having fed on beef lung showed a sex ratio that varied according to length of time the larvae were permitted to feed; namely, those lots which fed until voluntary migration from the food showed a sex ratio of from 2.8 to 3.1 males to 6.9 to 7.2 females, while those which were permitted to feed only 30 to 36 hours showed a sex ratio of from 6.2 to 6.5 males to 3.5 to 3.8 females.

2. Lots of flies (*Lucilia sericata*) resulting from larvae having fed on beef lung showed a variation in size from an average wing length of 4.2 mm. for those feeding 42 hours, to an average of 5.4 mm. for those having fed to voluntary migration. The longest wing lengths were, however, to be found among those flies having fed 54 to 60 hours, i.e., 6.7 mm. and the shortest wing length 3.3 mm. at 42 hours' feeding. The average size of the females was always greater than that of the males except in the lower feeding range (42 hours and less) when the males showed a slight advantage.

3. Lots of mosquitoes (*Theobaldia incidens*) resulting from larvae having been fed on Fleischmann's yeast in distilled water showed a sex ratio that varied according to the quantity of yeast supplied. Thus for one lot which resulted from larvae reared in water with one gram of yeast the sex ratio was 3.3 males to 6.7 females while for those resulting from larvae reared in water with four grams of yeast the sex ratio was 5.5 males to 4.5 females. This result is only partially supported by the results of a previous experiment. A tendency, however, appears to exist toward a preponderance of males as the result of larger quantities of food and a preponderance of females as the result of smaller quantities,—the reverse of *Lucilia sericata*.

4. Lots of mosquitoes (*Theobaldia incidens*) resulting from larvae reared in distilled water with Fleischmann's yeast showed a variation in average size ranging from an average wing length of 4.0 mm. for .5 gram of yeast, to an average wing length of 4.6 mm. for 5 grams of yeast, although the average wing length of those resulting from larvae reared on 3 grams of yeast was slightly greater, namely 4.7 mm.

PROCEEDINGS OF THE THIRD ANNUAL MEETING OF THE COTTON STATES BRANCH, AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The Cotton States entomologists held its third meeting, since becoming a branch of the Association, on December 29, 1927, at Nashville, Tenn. The session for papers was held jointly with the main Association, and a report of that session with the papers, which dealt particularly with entomological problems in the South, was given in Vol. 21, No. 1, of the Journal. Arrangements and entertainment for the 7th annual entomologists' dinner were provided by the Cotton States Branch. It was given in honor of Dr. L. O. Howard on the night of December 28, and proved to be one of the most pleasing that the Association has enjoyed at their annual conventions. A short business session of the Branch was held after the adjournment of the joint session on Dec. 29. At that session approval was given to the adoption of the common name cotton flea hopper for *Psallus seriatus* Reut. The Nashville meeting was adjourned to meet again in Memphis, Tenn., on Feb. 1, 2, and 3, 1928 in conjunction with the 29th Annual Convention of the Association of Southern Agricultural Workers, the Association with which the Cotton States Entomologists have been affiliated for many years.

BUSINESS PROCEEDINGS AT MEMPHIS

The meeting was called to order by Chairman G. M. Bentley at 2:00 P. M. on Feb. 1, 1928 in the Peabody Hotel at Memphis, Tenn. The attendance was good considering the fact that the Branch had already held a meeting in Nashville a few weeks before. There were sufficient papers for two long sessions as scheduled, and considerable discussion followed practically all of the papers. The following were in attendance at Memphis:

Alden, C. H., Cornelia, Ga.
Bailey, J. B., Knoxville, Tenn.
Bentley, G. M., Knoxville, Tenn.
Berl, C. W., Monroe, La.
Boyd, J. Hal., Memphis, Tenn.
Carpenter, H. H., Houston, Miss.
Coad, B. R., Tallulah, La.
Dean, J. M., A. & M. College, Miss.
Deen, R. B., Tupelo, Miss.
Douglass, N. L., Grenada, Miss.
Drinnon, Dana E., Knoxville, Tenn.
Ewing, K. P., Tallulah, La.
Fenton, F. A., El Paso, Tex.
Folsom, J. W., Tallulah, La.
Gaines, R. C., Tallulah, La.
Hamner, A. L., A. & M. College, Miss.
Harris, J. A., Raleigh, N. C.
Hinds, W. E., Baton Rouge, La.

Hobson, R. J., Bolivar, Tenn.
Howard, S., Monroe, La.
Kile, H. J., Knoxville, Tenn.
Kimball, H. H., A. & M. College, Miss.
King, W. V., Mound, La.
Lee, H. W., Tallulah, La.
Lyle, Clay, A. & M. College, Miss.
McGehee, T. F., Holly Springs, Miss.
Milton, J., Corinth, Miss.
Schoffelmayer, Victor H., Dallas, Tex.
Smith, F. A., Senatobia, Miss.
Snapp, Oliver, Fort Valley, Ga.
Turner, W. F., Macon, Ga.
Worthington, G. V., Cleveland, Miss.

REPORT OF THE TREASURER

Sale of dinner tickets at Nashville		$482.50
Contributions from members of Cotton States Branch		93.00
Refund from Main Association		5.60
Paid out		
Envelopes, postage, and index cards	$55.26	
Printing, zinc etching, and sketch invitations	23.75	
Hotel for banquet	372.00	
Entertainment for banquet	87.50	
Decorating banquet hall	35.40	
	$573.91	$581.10
Balance on hand, Feb. 2, 1928	7.19	
	$581.10	

REPORT OF THE SECRETARY

A card index of the entomological workers in the Cotton States was prepared during the year. During 1927 there were 182 members of the Association residing in the eleven Cotton States, and there were 204 workers in these states who were not members of the Association. All of these are not eligible for membership. An effort was made during the year to increase the membership in the Cotton States Branch. As a result 24 applications for membership in the Association were received and referred to the membership committee for attention at the Nashville meetings. A total of 1366 sketch invitations to the Nashville meetings was sent to entomologists in North America.

FINAL BUSINESS SESSION

Dr. Folsom called attention to the International Congress of Entomology that will be held at Cornell University next August. He is working on the section on cotton insects and asked for suggestions from the Branch as to that part of the program.

The following motion was passed at the final session:

"That the Cotton States Entomologists be extended the privilege of contributing one dollar or more to the treasury to defray Branch expenses."

The Resolutions Committee consisting of J. W. Folsom, F. A. Fenton and W. E. Hinds brought in their report containing the following eight resolutions, which were read and approved:

1. The members of this Branch express unanimously their appreciation of the courtesies extended to them by the management of the Hotel Peabody, which has in every way facilitated the success of the meeting.

2. Thanks are due, furthermore, to the members of the local press, whose efforts in the promotion of publicity have been of great assistance.

3. The meeting is indebted to Mr. L. H. Worthley for furnishing an exhibit of the European corn borer and its work, which was of great educational value and entomological interest.

4. The members of the Branch unanimously regret the illness of Dr. R. W. Harned and wish that he were with us.

5. To the State Plant Board of Mississippi the Branch is greatly indebted for its valued contribution in aid of the Nashville meeting.

6. The Nashville meeting, including the dinner in honor of Doctor Howard, could not have been made a success had it not been for the hearty assistance, financial and otherwise, of the members of the Cotton States Branch.

7. Message of sympathy to wife of late . Burger, plant pathologist.

8. This Association wishes to call especial attention to the news of a new infestation of the pink boll worm in the western portion of the main cotton belt. This outbreak is the most serious in the history of this pest in America and demands immediate and drastic action. The area already known to be infested, with the scouting still incomplete, involves over 100,000 acres of cotton with grave probability that further scouting will show even larger areas. Thus any means adopted to meet this situation will necessarily involve the expenditure of large sums of money. The menace now before us is so serious that this Association wishes particularly to urge the recognition of the fact that this problem has become not only southwide in importance but actually national, and that it is only by the coordinated support of the nation as well as the entire South that the fight can be carried to a successful conclusion.

The Secretary is requested to transmit these resolutions, respectively, to the proper persons.

The Nominating Committee consisting of Clay Lyle, W. V. King, and B. R. Coad presented the following names and they were duly elected: Chairman, F. L. Thomas, College Station, Texas; Vice Chairman, J. W. Folsom, Tallulah, La.; Secretary, Oliver Snapp, Fort Valley, Ga.

The meeting adjourned to meet next year with the Association of Southern Agricultural Workers at Houston, Texas.

CHAIRMAN'S ADDRESS COTTON STATES BRANCH

By G. M. BENTLEY, *Knoxville, Tennessee*

By way of introduction, I wish to commend our faithful Secretary for the efforts that he has made, and his success in getting the names and addresses of all the entomological workers in the eleven Southern States, the jurisdiction of activities of the Cotton States Branch. The results of his efforts were noticeable by the attendance of the southern entomological workers at the combined meeting of this Branch with the Economic Entomologists at the Nashville meetings. This effort of the Secretary should be appreciated by all of us, and we should help him in every way possible to keep him informed of any new men coming into service.

The following suggestions by your Chairman are made with the kindest of feelings, and are advanced at this time with the hopes that discussions will be entered into by different ones. I am hopeful of learning several new avenues of approach whereby we, as entomologists, may be of more direct benefit to the states which we represent. In that the central thought around which our presentations at this convention of the Southern Agricultural Workers whirls, is to be *Economic Factors in Agricultural Success*, I wish to tell you now (for fear you may not catch it from my paper) that the reader is entertaining this idea in a very broad sense, yet in a very important sense, which if rightly construed, is economic to the agricultural success of the states which we represent. The application of the suggestions embodied in this brief paper will enable us to accomplish more work with the money appropriated to us; to broaden our fields of endeavor; and to help Entomology as a pure and as an applied science to take the place in the activities of these days to which it is rightly due.

REGULATORY ENTOMOLOGISTS

It has often come to my notice that entomologists having to do with regulatory duties are losing opportunities of doing a real service by not meeting at conventions of organizations in which regulatory rulings have a direct bearing. The meetings, for instance, of the Southern Nurserymen's Association are rarely ever attended by the entomologists.

I cannot help but feel that this body of men, the nurserymen, would appreciate having the inspection officials with them at their conventions. I believe the unwarranted attitude that is held by some nurserymen against the inspection officials is due, in a large measure, to their not knowing them. Contact is a word in these days which means much. Contact and interpretation are levers, so to speak, which remove many difficulties. To get better acquainted with these men, and to get their viewpoint of our regulations, and to have the opportunity of explaining to them the importance of them, would mean a great deal, I am sure, in clarifying certain misunderstandings. In the presentation of their papers there is opportunity for us to learn certain things pertaining to the nursery business that will not be out of place at all in carrying out our duties, as the conventions, as a rule, are attended by the most active and well informed members.

TEACHING ENTOMOLOGISTS

Entomologists in charge of educational work have a wonderful opportunity of becoming acquainted with the State's activities wherein their services may be of direct benefit. I think all of us can come in closer contact, which will be the means of getting more people acquainted with the duties of the entomologists. To become closely identified, for instance, with the State Forestry Department would be a step in the right direction. Often they have entomological problems to which they do not give the recognition they should. If they knew we were keenly interested in their findings; if they knew that we would count as valuable material many specimens which they see, and that these specimens might be added to the State collections and be a real contribution to the entomological departments, I am sure that we would find among many of the rangers and the different members of the Forestry Department some real friends. Supplied with collecting equipment, they would be only too glad to collect material from time to time and send it in. This same inter-relationship of interests might equally be fostered by identification with the State Livestock Department, the Health and Sanitary Department, and the Seed and Feed Department.

If your State has an Academy of Science, your presence will be appreciated and they will be glad to have insect papers on their programs. For the members of the Academy of Science to know of your interests will mean much in your receiving material from different sections of the State. Associations of florists, truckers, beekeepers, canners, poultrymen, furniture men, wholesale grocerymen, the medical fraternity, the Audubon Society, etc. etc., is a list of only a few which you will find interested and anxious to learn more about insect life.

The research workers, the educational men, the regulatory officials and the extension entomologists in their respective states should be on the most intimate terms. Informal meetings or consultations, if you please, would be of mutual benefit to all. Possibilities for real dynamic work lie in the correlation and cooperation of your interests with the centers of pulsating activities. The business man is more interested in entomology than we give him credit of being. Any of you who have spoken before dinner clubs know this very well. The business men have many insect problems, either directly connected with their business, or their aspirations in certain investments on the side—as orchards, truck farms, conservatory for flowers, etc., and if they could only become acquainted with one who is interested in their problems, an intermingling of interests would be fostered of mutual benefit to both. Entomology can be made to be of such vitalization and stimulation that real worth-while constructive endeavors would be unified in a way that few sciences can do. The insect fauna of the State in which one is located should be studied, a collection made and notes properly filed. Most of those present, I am sure, have directed considerable attention along this line and it may not be out of place to stress the importance of State collections and the gathering of data pertaining thereto, but it is possibly from a different viewpoint that I would mention State collections at this time. If we had some means of knowing who of our membership is interested in certain groups, we might exchange material and notes which would be of very great value. For instance, at the Nashville meetings I accidentally learned of an entomologist who has made several collecting trips into Tennessee and has another trip planned for next spring for the sole purpose of collecting cynipid galls. He was surprised to learn that the galls of the State were being studied. The reader was equally surprised to learn of the State specimens taken. I will let you guess what a close friendship was immediately made, and of the mutual value that may result from exchange of notes. Only a few days ago Dr. M. R. Smith of A. and M. College, Mississippi, furnished some very valuable locality notes of ants that had been taken in the State. I feel quite confident that many listening to this paper have notes on insects which have been taken in the State of Tennessee, which if added to our accession files, would prove of very great interest. This is doubtless true for all of the states.

With the development of the National Park in the Great Smoky Mountains, many entomologists will be attracted to that section and may take species not recorded in the State lists. It may be of interest for some of you to know that Gatlinburg, which can be reached from Knoxville over a good highway in an hour and a half, has a hotel with all modern conveniences. The altitude of this section is 1400 ft. An hour and a half's walk from this quaint little mountain town will bring you to Mount LeConte which has an altitude of 6,680 ft. There are few, if any, places in the Eastern United States where a mile altitude can be reached in so short a time and covering a section of such varied flora. In this regard the section has much to offer over the conditions which exist even in North Carolina, where Mt. Mitchell attains an altitude of 6,711 ft. In each state there are ideal collecting regions to which entomologists are attracted from time to time, and any notes taken would be appreciated by the entomologist in the state.

In closing, I want to thank the members of the Cotton States Branch for their efforts in making the Nashville meetings a success. The attendance from the eleven Southern States was most gratifying and all called upon were only anxious to lend their support in putting over an interesting and instructive program and the entomologists' dinner that will be long remembered by all in attendance. By your sympathetic interest and willing cooperation, you have given proof sufficient to the parent Association of your high appreciation of affiliation which the Association so graciously bestowed upon us two years ago. As your Chairman, I wish to commend you for all of your activities.

PREDICTING SERIOUS COTTON APHIS INFESTATIONS

By A. L. HAMNER, *Mississippi Agricultural Experiment Station*

ABSTRACT

One season's results indicate that when a cotton aphis infestation as high as 5% exists at the time calcium arsenate dusting for the boll weevil is started a heavy infestation may be expected if as many as four applications are made.

For several seasons cotton planters have occasionally been troubled with serious cotton aphis infestations following calcium arsenate applications for the boll weevil. These infestations have not always followed regular boll weevil dusting, but have occurred in some cases. Just why these infestations do not regularly follow commercial boll weevil dusting has probably been, at some time or another, a question in every entomologist's mind who is interested in cotton insects. If at the time dusting is started for the boll weevil the planter could predict whether or not a serious aphis infestation would follow, it would be of great value to him. The method of doing this should be simple and should not require more time than that necessary to take the average boll weevil infestation.

The results presented here cover only one year's work, and are by no means conclusive. However, the writer believes them worthy of further consideration and is publishing them so that entomologists working with this insect may have advantage of these rather limited experiments conducted along this line.

During the season of 1926 while dusting cotton with calcium arsenate to increase the aphis infestation, it was noted that the infestation rose very slowly until it had reached approximately 10%, after which it climbed rapidly. The infestation was very low when the dusting was started, seldom exceeding 1%. Six applications of dust were made before the plats with the higher infestations reached 10%, a majority of them running between 4% and 7%. After the infestation had reached approximately 10%, an increase ranging from 35% to 50% was produced with fewer applications of calcium arsenate than were required to bring it to 10%. The dusting was continued to within two days of the time these infestations occurred, and we now know that a part of these dusting operations were unnecessary. However, the rapid increase from the approximately 10% infestations suggested that possibly there is a certain percentage necessary at the time commercial boll weevil dusting is started for a serious aphis infestation to occur. After studying our records 10% was assumed as the maximum necessary if this is a determining factor.

METHOD OF TAKING INFESTATIONS

The series of photographs issued by the Boll Weevil Laboratory at Tallulah, Louisiana, was used in making the infestation records, with one exception. In 1926 we divided the 1% to 10% division into two parts, 1% to 5%, and 6% to 10%. This gave us slightly more accurate records for the lower infestations. The average of one hundred plants selected at random, each time, on the middle rows and near the same points, was taken as the infestation for the plat.

1927 EXPERIMENTS

Experiments planned for 1927 were to dust cotton until the infestation reached 10%, then to kill the aphids off on one plat with nicotine dust, using calcium arsenate and hydrated lime in equal parts as the carrier.

The other plat which had been treated in the same way previous to the application of the nicotine dust was to receive an application of calcium arsenate on the same day. This was to be followed by three additional applications of calcium arsenate. The first of these experiments was allowed to run until the infestation ranged from 13.2% to 16.3% on the four plats, before the nicotine dust was applied. It was necessary to discontinue the dusting after these applications. One-eighth acre plats were used. The experiment is represented by Table 1.

TABLE 1

Date Treated	Inf. Taken	Plat VIII % Inf.	Plat IX % Inf.	Plat X % Inf.	Plat XII % Inf.
	June 13	.9	1.3	.9	.5
June 18					
June 24					
June 27					
	June 29	3.6	3.7	3.9	3.6
June 30					
July 5					
	July 6	7.5	8.5	8.1	9.5
July 8					
July 11	July 11	14.1	13.8	13.2	16.3
July 12		*	0	*	0
	July 13	5.7	14.7	5.4	21.3
	July 20	11.6	53.3	10.7	61.1

0—No dust applied.
*—Plat dusted with nicotine dust.
Check plat June 16, 2.6%; July 22, 7%.

The above table shows the results obtained from seven applications of calcium arsenate. It was necessary to discontinue the dusting after the applications of nicotine were made on July 12. It is probable that there was some cumulative effect of the applications made on June 18, 24, and 27. However, these data show that with this cumulative effect serious aphis infestations may develop from 3.5% to 4% by making four applications of calcium arsenate. They also indicate that the assumed 10% aphis infestation at the time dusting is started for the boll weevil is too high.

Plats VIII and X which were dusted with nicotine dust July 12 increased from 5.7% and 5.4% to 11.6% and 10.7% respectively, while plats IX and XII increased from 14.7% and 21.3% to 53.3% and 61.1% respectively, during the period between July 12 and July 20. The check plat had an infestation of 2.6% on June 16. By July 22 it had increased to 7%.

In the latter part of June a small field of cotton was found having more aphids on it than are usually found on undusted cotton. Three plats of one-eighth acre each were laid off and infestation records made. Four applications of calcium arsenate were made on plats II and III with the exception of July 6 when plat II received an application of nicotine dust using calcium arsenate and hydrated lime in equal parts as the carrier. The results of this experiment are shown in Table 2.

TABLE 2

Date Treated	Inf. Taken	Plat I Check % Inf.	Plat II % Inf.	Plat III % Inf.
	June 30	5.0	5.9	5.4
July 1				
	July 5	5.1	10.1	9.2
July 6*				
	July 8	5.7	5.4	13.0
July 9				
July 12				
	July 22	11.1	11.5	48.3.

*Plat II received application of 7½% nicotine sulphate dust. Plat III received application of calcium arsenate.

The above table shows the results obtained from four applications of calcium arsenate with a starting infestation of approximately 5%. The infestation on plat III which received four applications of straight calcium arsenate rose to 48.3% by July 22, while that on plat II which had received the application of nicotine dust and three of straight calcium arsenate increased to 11.5%. The check plat had an infestation of 11.1% on this date.

About the first of August a field was found having a comparatively high infestation for undusted cotton. Two points were selected and three plats of one-quarter acre each were laid off at each point. One series (Cut 1) was dusted with calcium arsenate until the infestation reached 9.5% on one plat. The other dusted plat had an infestation of 7.9% and was used as the nicotine plat. The plats received seven applications of dust, four of which were after the infestation had reached 9.5% on plat II.

The other series (Cut II) was dusted four times, Cyanogas calcium cyanide was used on plat 1 for the fourth application. The plants were very slightly moist and considerable burning resulted. The plat was discarded after an attempted infestation record on August 20.

The results of these two methods of treatment are shown in Tables 3 and 4.

TABLE 3, CUT I

Date Treated	Inf. Taken	Plat I % Inf.	Plat II % Inf.	Plat III Check % Inf.
	Aug. 6	6.6	7.7	6.0
Aug. 9				
	Aug. 11	6.7	7.4	5.9
Aug. 12				
Aug. 15				
	Aug. 16	7.9	9.5	5.1
Aug. 18*				
	Aug. 20	5.2	13.4	5.1
Aug. 22				
Aug. 25	Aug. 25	6.1	21.9	5.0
Aug. 29				
	Sept. 2	12.5	65.9	5.8

*Plat I dusted with 7½% nicotine sulphate dust, calcium arsenate and hydrated lime in equal parts as carrier.

The infestation increased to 12.5% on plat 1 (nicotine dusted) by September 2, while that on plat II increased to 65.9%. The check showed a decrease of 1% during the experiment but increased to 5.8% by the time the final infestation records were made.

TABLE 4, CUT II

Date Treated	Inf. Taken	Plat I % Inf.	Plat II % Inf.	Plat III Check % Inf.
	Aug. 6	6.3	6.0	6.3
Aug. 9				
	Aug. 11	7.5	7.6	6.0
Aug. 12				
Aug. 15				
	Aug. 16	13.2	12.0	5.3
Aug. 18*				
	Aug. 20	11.9	16.7	5.2
	Aug. 25	0	24.6	5.2
	Sept. 2		51.6	6.1

*—Cyanogas calcium cyanide on plat I.

0—Discarded because of partial defoliation from burning by calcium cyanide dust.

Plat II which had an infestation of 6% on August 6 increased to 12% before the fourth application of dust. By September 2 it had increased to 51.6%. The check having approximately the same infestation at the start decreased slightly till the latter part of August. A slight increase is shown in the last infestation record.

SUMMARY

Heavy aphis infestations were produced with four applications of calcium arsenate when the infestation was 5% or more at the time dusting was started. Infestations from 13% to 16% at the time dusting was stopped produced serious aphis infestations. Additional applications after this percentage (13 to 16) was reached did not affect the infestation to any great extent. Nicotine dusts applied during the dusting period were not satisfactory.

THE EFFECT OF THE SPACING OF COTTON UPON THE FORM AND HEIGHT OF THE PLANT

By W. E. HINDS, *Entomologist, Louisiana Experiment Station*

ABSTRACT

This paper reports results of cotton growth on Mississippi River Bottom soil at the Louisiana Experiment Station, Baton Rouge, Louisiana. In 1924, with total rainfall of 7.15 inches during June, July and August, Salisbury cotton averaged 1588 pounds seed cotton per acre. The same variety on similar soil in 1925, with a normal rainfall amounting to 14.48 inches during June, July and August, produced an exceedingly rank weed growth with abundant blooming but practically complete shedding of small bolls and no crop was picked.

Spacing tests were conducted in 1926 with Lone Star No. 65 cotton on similar soil, planted June 25 and records completed by September 25. Rainfall during June, July and August amounted to 25.51 inches and a severe tropical storm occurred on August 25, when over 10 inches of rain fell. The widest spacing, single plants 24 inches apart, produced invariably the lowest and broadest growth with thickened bases to the stalks, heavy vegetative branches and delayed setting of bolls. The unthinned cotton was extremely slender and whip-like with no vegetative branches and very few bolls. In all spacings varying from single stalks at 8 inches to 3 to 5 stalks per hill, there developed a practically full stand of from 16,000 to 18,000 stalks per acre having "normal growth" and fruiting. These stalks were, as a rule, moderately slender, with few if any vegetative branches and reaching a rather uniform height of 38 to 42 inches at three months of age. Hill spacing with 3 to 5 stalks at 12 to 15 inches apart appeared to give the most practicable and desirable spacing.

During recent years a great deal of work has been done by various Experiment Stations in testing the effect of spacing of cotton upon the yield secured under conditions of boll weevil infestation particularly. These tests have shown in practically all cases that it is advisable to plant the rows as closely together as can be done with due allowance for the normal height of the plants and the culture required upon any particular type of soil and also to leave the plants much thicker in the row than growers had been accustomed to doing. In most of these tests the final decision as to the spacing to be recommended has been based upon that giving the highest total yield of seed cotton per acre at harvest time. In connection with this work very little has been published in the way of illustrations which would show the net result of various spacings, soil and moisture conditions upon the shape and growth of the plant.

It has been stated repeatedly by investigators that close spacing in the row tends to suppress the growth of the heavy vegetative branches which are produced near the base of the plant where an abundance of space occurs about it. Many planters are accustomed to estimating their prospective yield under the spacing and cultural conditions which they are accustomed to practice by counting bolls and estimating the average number of bolls per stalk which they may reasonably expect to harvest. However, we believe that comparatively few farmers have adopted the practice of basing such estimates upon the more reliable foundation of the average number of bolls to be matured per acre and dividing this number by the average number of bolls required to produce a pound of seed cotton with whatever variety they are growing. This more accurate estimate determines simply the approximate number of "row-feet" per acre at the average width of row at which they are planting. The number of assured bolls per 100 row-ft. is then determined at five or more points representing an average condition as to spacing, plant growth and fruitage for the field. If this method is followed, the grower will quickly come to appreciate the importance of having a maximum number of stalks reaching practically normal development and producing early in the season a large crop of bolls. Any information which will help the planter to understand this thoroughly would seem to be worthwhile. It is not too difficult a matter for the planter of average intelligence to determine the number of row feet per acre actually planted in cotton by dividing the number of square feet in an acre (43,560) by the number of feet in the average distance between the rows. Then to produce a crop of a bale per acre, or roughly 1500 pounds of seed cotton, he will require for varieties having medium sized bolls approximately 120,000 and for small boll varieties 150,000 bolls per acre. On this basis he finds quickly that at 3½ feet between the rows he must produce at least 10 bolls per row foot with the medium sized bolls and 12 of the small size to secure this desired yield. Also he becomes impressed with the fact that the further apart he plants his rows the larger the number of bolls per row foot he must secure, and he finds that it takes also a longer time to get this with the widely spaced cotton.

If the cotton planter can get a clear vision of the effect of spacing upon the form of the cotton plant, the region within which it sets its fruit and the distribution of bolls to secure his desired yield, it should help him in determining the most ideal spacing for his variety of cotton, soil and average moisture condition.

At the Louisiana Experiment Station in 1926 a test of spacing was undertaken to explain in a measure, if that could be done, a very wide variation in cotton fruiting which had occurred on similar Mississippi River bottom soil in 1924 and 1925. A brief description of this earlier experience must, therefore, be given.

In April 1924, a 3½ acre plat was planted with Salisbury cotton and produced that year an average yield of 1588 pounds of seed cotton per acre. The rainfall during June, July and August, 1924 was exceedingly scant, amounting to a total in thirteen weeks of only 7.15 inches. Nearly half of this fell during the first week of June just as the cotton was beginning to fruit and nearly one-third of it came the middle of August after the crop had been set. The drought conditions were so severe as to be very unfavorable indeed for sugarcane, but the soil retained moisture sufficient to favor the fruiting of the cotton. This cotton was kept dusted for boll weevil control and through the combined effect of the drought and the dusting, a considerable top crop was set and matured.

On an adjacent plat having the same type of soil but on which the crop of corn stalks and soy beans grown in 1924 had been plowed under, another crop of Salisbury cotton was planted in April, 1925. The climatic conditions seemed to be very favorable for plant growth during the spring and up to the beginning of squaring. From that time on, however, the rainfall was, on the whole, practically normal for June, July and August, amounting to 14.48 inches total. This was almost exactly twice the rainfall occurring in 1924 and rain fell on one-third of the days during this period. Under these conditions and with the large supply of organic nitrogen stored in the soil, the cotton put on a very rapid growth. Growth was so rapid that practically all small bolls were shed within a few days after blooming had passed. Weevil control by dusting was very satisfactory and infestation percentages remained low until dusting ceased about the first of August. Square infestation was below 24% on dusted areas on July 30, while in the undusted check it had passed 58%. The dusted portion was a veritable flower garden during this period from the middle of June to the end of July. The weevils did not interfere at all with the setting of bolls. The growth of the plants was amazing both in the unusual size and tenderness of the tops and stalks and in the small development of roots accompanying it. The rows were planted 5½ feet apart as the cane rows would be spaced, and the spacing in the row averaged 1.6 stalks per row foot. It was anticipated that such closing spacing in the row would be sufficient to hold down the vegetative growth of the stalks, but this did not happen. This cotton set practically no bolls whatever and being without a load of fruit, the growth of "weed" was enormous. The branches overlapped in the rows so that it became practically impossible to push one's way through the field. At the end of the season stalks averaged about 9 ft. in height and many of them were over 2 inches in diameter near the ground.

In this case spacing seemed to have practically nothing to do with the setting of fruit. There were no more bolls upon end plants in the rows or on the outside rows or where skips occurred in the field. The cotton was stripped by the leaf worms during August and September except upon one corner where, as an experiment, the plants had been thinned about the middle of August to 2 ft. apart and cut back to about 3½ ft. high. This test was made to see whether such drastic treatment would affect the setting of fruit and the retention of bolls. On this corner the new growth began to produce blooms after the middle of September and bolls were set with wonderful rapidity, but it was too late in the season for them to mature. So no cotton was picked from this entire area of about 3½ acres.

The extreme variation in yield conditions on this soil in 1924 and 1925 led to the 1926 spacing tests. It was intended that this cotton should be planted moderately early and that the records should include total yield under weevil control conditions. However, the planting was made on a newly broken area and the rainfall and soil conditions would not allow planting to be done until June 25. The variety used was Lone Star No. 65. This late start made it certain that no reliable yield comparisons were likely to be secured. The area was fairly well cultivated and received three applications of calcium arsenate but these were not given at proper intervals to secure greatest effectiveness in weevil control and dusting ceased after Aug. 15, or when the cotton was only seven weeks old from planting date. It was then stripped by leaf worms between September 10 and 20 and all further prospects of fruiting were stopped thereby. This stripping of the plants assisted decidedly in revealing the striking differences in the growth of the stalks which have occurred very uniformly throughout the various replications in the planting. All bolls except those which were nearly mature shed within a few days after the cotton was stripped and this accounts for the very small number of bolls reported in these comparisons. It should be borne in mind also that this cotton had reached this stage of maturity in about 11 weeks after it was planted.

In this field all rows ran east and west and the distance between rows was approximately 3.7 feet. The spacing represented in the rows was intended to represent the following: Unthinned; 1 stalk X 6 inches; 1 stalk X 12 inches; 1 stalk X 24 inches; 3 X 12 inches; 5 X 12 inches; 5 X 18 inches. As a matter of fact, however, the spacing actually left by the cotton choppers was not as accurate as was desired. The actual spacing as it occurred in the areas recorded is shown in the table and the illustrations were photographed to show average plant conditions where the typical spacing occurred.

The rainfall conditions in 1926 were extremely wet. June and July were near the normal in rainfall, but over 17 inches fell during the month of August. Of this amount 10.05 inches fell during the tropical storm on August 25. The heavy wind occurring at this time laid most crops flat on the ground. The effect is shown clearly in the inclined position of the stalks in many of the illustrations. This is particularly noticeable among the widely spaced plants which were blown over most completely and is shown least in the unthinned rows where the growth was so slender and willowy that the stalks showed no effect of the storm four weeks after it occurred. This storm also served to decrease the amount of fruit set in these tests. For these reasons we consider that the actual number of bolls recorded while it is no measure of normal fruitfulness, does indicate a reasonably fair comparison in the fruiting conditions existing in these various plats. Certainly the tests should be repeated so as to include a season with a normal growing period and fairly favorable fruiting conditions.

TABLE 1. SUMMARY OF ALL RECORDS SHOWING EFFECT OF SPACING UPON STAND, HEIGHT, NORMAL GROWTH AND FRUITING IN LONE STAR NO. 65 COTTON, GROWN ON MISSISSIPPI RIVER BOTTOM SOIL AT BATON ROUGE, LOUISIANA—1926. PLANTED JUNE 25 AND EXAMINED SEPTEMBER 15, 1926

Spacing Pls. X Inches	Distance Examined Row-ft.	Normal Plants No.	Average Height Inches	Averages per 100 row-feet No. Normal Plants	No. Dwarfed Plants	No. Maturing Bolls
1 X 24	800	410	33	51	7	150
1 X 12	900	862	35.4	96	7	147
1 X 8	700	1023	37.6	146	9	166
3 X 12	800	1840	42	230	46	190
3–5 X 14–18	800	1766	38.5	221	96	178
3–5 X 24	200	446	35.5	223	55	185
Unthinned	200	661	36	330	761	80

The principal records on growth, fruiting and rainfall are shown in Tables 1, 2 and 3.

In the study of growth of plants there seems to be a fairly sharp distinction between those which are "stunted" and decidedly below average size and lacking in fruit, and the plants which are "normal" which approach average size for that spacing and appear capable of bearing fruit. The number of replicated plats examined for the record is indicated by the number of hundred row-feet in the total distance examined.

TABLE 2. RAINFALL RECORDS, BATON ROUGE, LOUISIANA (U. S. WEATHER BUREAU) LOUISIANA EXPERIMENT STATION JUNE, JULY, AUGUST: 1924, 1925, 1926

Weekly Interval		1924		1925		1926	
Month	Days	Rain Inches	No. Days With Rain	Rain Inches	No. Days With Rain	Rain Inches	No. days With Rain
JUNE	1– 7	2.97	3	.72	3	.74	3
	8–14	0	0	3.47	5	.95	2
	15–21	0	0	.61	4	1.94	2
	22–29	.38	1	.41	1	.43	2
JULY	30–7/5	.48	1	.02	1	.16	1
	6–12	0	0	2.40	4	1.21	4
	13–19	.07	1	3.78	4	.98	1
	20–26	0	0	0	0	2.33	4
	27– 2	.41	1	1.16	1	.60	2
AUG.	3– 9	.41	2	.20	1	.46	1
	10–16	2.14	1	.15	1	4.48	5
	17–23	.28	3	1.10	1	1.18	3
	24–31	.01	1	.46	4	10.05	4
Totals: 13 Wks.		7.15	14	14.48	30	25.51	34
Weekly Average		.55	1	1.11	2.3	1.96	2.6

A few general field notes upon the growth and fruiting of cotton in these tests may be of interest. In an average strip of unthinned cotton there was found within a distance of 200 feet, 1522 plants which had started to grow. Of this number only 661 had approached the average height of the taller stalks in the row, and the height in this case for so-called "normal plants" was 36 inches. All of the plants were very slender and willowy in growth and completely devoid of vegetative branches. In this distance of 200 row-feet was found a total of 173 bolls that would mature. Of this number, 159 were growing on the so-called "normal stalks" and only 14 were found upon the total number of 1522 distinctly "dwarfed stalks." In one strip of 100 row-feet examined among the 66 bolls found thereon, at least 62 were borne distinctly on the south side of the row where exposed to the fullest amount of sunlight. Only 4 bolls occurred on the north side of the plants in this strip, and there were no bolls whatever through the middle of the row with these closely spaced plants. The range in height of so-called "normal plants" was from 34 to 38 inches and fully two-thirds of the "dwarfed plants," among the unthinned, had failed to reach 24 inches in height. Upon the best drained and richest spots a few of the unthinned plants had reached the maximum height of 46 inches. In the unthinned cotton bolls occurred at from 6 to 30 inches above the ground and not a single boll rested upon the ground. Bolls were here borne decidedly higher from the ground than was the case with single plants standing at 12 or 24 inches apart. The unthinned plants blew over less during the Gulf storm and stood much more erect a month after the storm than did those at any other spacing.

The most striking contrast in width of spacing was in the row planted a single stalk at 24 inches apart. These plants were invariably lower in height and broader in growth than at any other spacing. The bases of the stalks were very much thickened and the vegetative branching was much more highly developed. Many of the bolls on these stalks were resting on the ground and would probably have rotted before opening. The widest spacing was at the rate of 4,100 plants per acre. This spacing showed the highest number of bolls per stalk but averaged only 1.6 bolls per row-foot. The best fruited single plant found in the field bore 15 bolls and occupied a space of 48 inches to the nearest plant each way. The widely spaced plants made the lowest growth of all. Height increased steadily and regularly as the spacing approached three stalks in a hill and with hills approximately 12 inches apart at which spacing the maximum average height of 42 inches and the maximum boll formation per 100 row-feet occurred.

An examination of Table 1 indicates that in these tests there was a rather surprising uniformity in the number of stalks making "normal growth" when from 3 to 5 plants were left in hills standing at from 12 to 24 inches apart. The number of "normal stalks" was very close to 18,000 per acre in each of these three tests and this figure seems to indicate approximately "a full stand of cotton" on this soil. The number of bolls maturing per 100 row feet was also strikingly similar in each of these tests and ranged from 178 to 190.

The effect of these various spacings upon the growth of the plant in its height, form and branch development especially is shown much more clearly in the illustrations than it can be described in words. It would seem that most of these differences would have been exaggerated still more had the plants grown through a normal length of season instead of the less than three months which actually occurred in this case.

While the work of one season can never be considered conclusive in a study of this kind, it may yield certain impressions and tentative conclusions which may be worth following up with additional tests or even applying them in field practices. At least two such tentative conclusions seem to be indicated in this case:

First, on Mississippi River bottom soil of average fertility and without fertilizer a stand of approximately 18,000 stalks per acre may be considered "a full stand" and likely to give maximum yields, with rows at 5½ feet apart.

Second, a spacing by which groups of from three to five stalks are left in a hill and with hills standing at from about 12 to 24 inches apart may be relied upon to produce a full stand of normal plants with prospect of maximum yields.

POISONS FOR CUTWORM BAITS

By Clay Lyle, *Mississippi State Plant Board*

Abstract

A comparison of Paris green with sodium fluosilicate in poison baits against the greasy cutworm, *Agrotis ypsilon*, and the southern grassworm, *Laphygma frugiperda*, indicated that Paris green is more rapid in its action and considerably more toxic, and that *A. ypsilon* is more easily killed than *L. frugiperda*. The tests were made in individual salve boxes with about 300 worms.

A conference of entomologists was held at Vicksburg on June 1 last year for the purpose of formulating plans for combating the anticipated outbreak of cutworms and grassworms following the Mississippi River overflow. Among the topics discussed at this meeting was the question of poisons for bran mash baits. It was decided that there was sufficient evidence to justify the recommendation of sodium fluosilicate as being equally or even more effective than Paris green. As this chemical had never been used in Mississippi for this purpose, there was some hesitancy about giving it an unqualified endorsement without first trying it on a small scale.

These tests were made in individual salve boxes with about 300 worms, chiefly the greasy cutworm, *Agrotis ypsilon*, and the southern grassworm, *Laphygma frugiperda*. A few specimens of the yellow-striped armyworm or cotton-boll cutworm, *Prodenia ornithogalli*, were also used. In all cases the greasy cutworms were more quickly killed than the grassworms, and in every test the Paris green proved considerably more toxic than the sodium fluosilicate. Each poison was used at the rate of one pound to 50 pounds of wheat bran, with enough water to make the mash thoroughly moist but not sloppy. The detailed results of several of the tests are given herewith. Several other tests are not described here on account of the wide variation in the time periods at which the boxes were examined.

COMPARISON OF PARIS GREEN AND SODIUM FLUOSILICATE BAITS AGAINST *Agrotis ypsilon* AND *Laphygma frugiperda*

	No.		Mortality	
Species—*Agrotis ypsilon*	Worms	15 Hours	24 Hours	48 Hours
Sodium fluosilicate	15	11 or 73.3%	12 or 80%	13 or 86.7%
Sodium fluosilicate	25	————	15 or 60%	20 or 80.0%
Average mortality			70%	83.4%
Paris green	10	7 or 70.0%	10 or 100%	
Paris green	12	9 or 75.0%	11 or 91.7%	12 or 100%
Paris green	16	15 or 93.7%	16 or 100%	
Paris green	9	9 or 100%		
Average mortality		84.7%	98%	100%
Species—*Laphygma frugiperda*				
Sodium fluosilicate	14	1 or 7.1%	2 or 14.2%	8 or 57.1%
Sodium fluosilicate	17	5 or 29.4%	6 or 35.3%	9 or 52.9%
Sodium fluosilicate	12	6 or 50.0%	9 or 75.0%	10 or 83.3%
Sodium fluosilicate	12	6 or 50.0%	8 or 66.7%	
Average mortality		34.1%	47.5%	64.4%
Paris green	16	14 or 87.5%	Same	16 or 100%
Paris green	17	15 or 88.2%	16 or 94.1%	17 or 100%
Paris green	12	10 or 83.3%	Same	11 or 91.7%
Paris green	10	7 or 70.0%	8 or 80	
Paris green	12	10 or 83.3%	11 or 91.7%	
Average mortality		82.5%	87.3%	97.2%

It will be noticed from the wide difference in results at the end of the first 24 hours that the Paris green is much more rapid in its action, which is of considerable importance where it is desired to stop the ravages of the worms as quickly as possible.

It is realized that these tests are not extensive enough to draw definite conclusions, but they are sufficient to raise doubts as to the wisdom of substituting sodium fluosilicate for Paris green in poison baits for these two common species.

"BILLING YARD INSPECTION OF NURSERY STOCK"

By DANA E. DRINNAN, *University of Tennessee*

ABSTRACT

This paper deals more with the different types of inspection, rather than billing yard inspection. The types of inspection may be as follows: Field, Destination and Billing Yard. The type most used is Field Inspection. The purpose of this inspection is to detect insects and diseases during the growing period and to correct them. Certificate is issued on this insepction. There are both advantages and disadvantages in this system. The inspection of Destination is made when trees or plants are delivered. Billing yard inspection is given when trees or plants are being shipped. All diseases and irregularities are checked during this inspection. Its importance cannot be overestimated.

Neither of the threc systems when used alone is sufficient. Best results can be obtained from combination of the three.

I have been asked to speak on the subject of Billing Yard inspection of Nursery stock. A discussion of this subject would probably be more appropriate at a meeting of quarantine officials but since many of those here are in some way connected with regulatory work maybe it will not be out of place to discuss it here. What few remarks I have to make will be more on the different types of Inspection, which of course includes "Billing Yard Inspection." They all are so interwoven and dependent on each other, that it is difficult to discuss any one of them without discussing the others.

Inspection work as you all know may well be divided into three types: Field, destination and billing yard, each having its advantages and its disadvantages. These types, it is my intention to discuss.

The first and perhaps the most general type used is that of Field Inspection. This, as the name indicates is that type of inspection made in the field while the nursery stock is growing and upon which the certificate is issued. Now this type has its advantages, but it also has its disadvantages. It is almost impossible to institute a system of regulatory work without some sort of field inspection. Many of the plant diseases and injuries from insects can best be detected while the trees are growing. Certainly it is essential that the premises be inspected for they often are the source of infection or infestation as the case may be. Then, too, injuries may be detected before they have become serious. That can be remedied or controlled and that is one of the reasons for making inspection.

Field inspection is also necessary to find out who have nursery stock for sale and get them lined up for later inspection if any other type is used. This is especially true in states where there is a large number of nurseries or plant growers. Neither one of the other types if used alone could be practical. But as I said before, it has its disadvantages. If it is the only system employed, these disadvantages are serious ones. Many of the trees or nursery stock may apparently look to be free from disease, but when they are dug, may show serious infected or infested root systems as hairy root and woolly aphis on apple trees. In this case field inspection is no good and a certificate given on such an inspection would not mean much. Again, field inspections are often made before the nursery stock has made very much growth. In some cases they are made from three to six months before the stock is offered for sale: This in itself is a serious objection. Insects multiply rapidly and can spread within that period of time. So can diseases. Though the nursery stock is free at the time of inspection, it may become infested before it is offered for sale.

This brings up the subject or advisability of issuing a certificate and shipping tags based upon an inspection made in the summer of this year entitling the holder to ship nursery stock until this time next year. When the field inspection is used alone, the nursery will probably not be visited again by the inspector until the regular time for inspection next year. Many things can happen within a year's time. Tags may be traded or bartered by unscrupulous nurserymen. Is there any wonder that sometimes objection is made to the regulatory work?

The second type of inspection is that of Destination. This is made as the nursery stock is being delivered at the point of its destination. The inspector can see just what the buyer is getting and can reject anything which may in any way look questionable. But states having small appropriations with few inspectors can hardly make this type of inspection obligatory. To have all shipments of nursery stock pass through a few certain points of inspection would require a good deal of expense to open and repack the shipments. It would also often result in injury to the trees through delay.

The third and last type of inspection is that of "Billing Yard." This, as the name indicates is that inspection made when the trees are being sent out from the billing yards. States which have only a few large nurseries can use this as the only method. The inspectors can be on the premises at Billing time and grade the nursery stock and issue the tags as the packages are shipped but it is most practical to have both field and billing yard inspection. We find that a combination of all three types works best and we feel that the importance of the Billing Yard inspection cannot be over-estimated. For it is this inspection which determines just what shall be sold and what must go to the cull-pile and be destroyed. It is here that crown gall, hairy root and blotch are detected on appletrees, nematode and gall on peaches, and woolly aphis and San Jose scale insects on apples. A strong effort is made to see that all nursery stock shipped out is seen by the inspector before it leaves the Billing Yard. In many cases the inspectors grade the trees themselves. This is often true in the case of the smaller nurserymen. We have been able to help a great many inexperienced nurserymen by assisting them in their grading work and by showing them the effects of diseases and insects.

Neither of the systems when used alone is, in my opinion, sufficient. A combination of the three is best. But so often appropriations are so limited that a perfect system cannot be employed. In such cases what types are we going to use? Would it not be well to have an adopted, uniform system of inspection and certification which would be acceptable to all the state authorities? Certainly. I don't see how it can work any harm.

EFFECT OF OVULATION UPON SEASONAL HISTORY IN THE ALFALFA WEEVIL

By S. J. Snow, *Assistant Entomologist, Cereal and Forage Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture*

Abstract

Larvae of the alfalfa weevil, *Phytonomus posticus*, occur sparingly throughout the summer after the greater number have become adults. They are too few to injure the third and fourth crops, upon which they occur, but they raise the question whether they belong to a second generation which might, under other climatic conditions, become injurious. To determine this point it was necessary to collect, dissect, and examine the reproductive organs of hundreds of female beetles of all ages. From the history of ovulation thus established, it is evident that the few surviving old beetles produce the late summer eggs and larvae.

Introduction

The alfalfa weevil passes the winter mainly in the adult stage in alfalfa fields and in ditch banks, fence rows and similar places. Eggs are deposited by these overwintering beetles in the spring, and by May or early June larvae may be feeding on the alfalfa in large numbers. After three to six weeks the larvae spin cocoons and by the middle of summer the resulting young adults are abroad and greatly outnumber the old ones, which gradually die off after their heavy egg-laying in the spring.

The life history briefly indicated above is the normal one under the climatic conditions of the Great Basin. However, for a long time it was known that, besides the weevil larvae which feed in May and June, others were present in small numbers throughout the summer and fall and it was a matter of speculation whether they were the offspring of the new generation of beetles produced in midsummer or of the old ones, which sometimes lived until October. In order to get anatomical evidence upon this point and to learn when the period of ovulation began, how it progressed and when it ended, female weevils of both generations were collected from a variety of environments and at all seasons of the year during 1913, 1914, and 1915 and dissected.

THE DIFFERENCE BETWEEN YOUNG AND OLD WEEVILS

In this paper, beetles which emerge in the spring and summer are classed arbitrarily as *young* during fall and winter, and as *old* or overwintering after the beginning of March. It is only from May to October, when the two generations of adults overlap, that they need to be distinguished, and during this period they can usually be separated by the difference in color. The old beetles are much darker than the young, mainly because of the wearing off of the minute, light brown or gray scales and the darkening of the chitin. This difference, however, is not always marked enough to be a reliable means of separation. The change in color from light brown to dark brown does not all take place during the winter, as reported in early studies[1] of the weevil, but chiefly later on near the beginning of summer; and even in the late summer old beetles are occasionally found with the scales not entirely removed and the color not distinctly dark. It was tnis which led early observers to believe that females of the younger generation had produced fertile eggs in the late summer. Later, in experimental rearings of adults known to be young, no oviposition was observed until late autumn—two to three months later, presumably, than the time of oviposition noticed by earlier workers. Perhaps the "young" weevils of the earlier records were really old ones which had escaped weathering. This uncertainty frequently made dissection necessary to distinguish the two generations, and by the dissection of a large number of the young weevils it was possible to determine the age at which oviposition begins.

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[1] "While the beetles go into hibernation in nearly perfect unrubbed condition, they emerge in the spring with scales and pubescence removed to such an extent that they are almost black in color, smooth and shining. This appearance so contrasts with that of the newly-emerged adults of the new generation that the latter can be easily separated at sight, and it was these latter that again and again were observed to oviposit and their eggs to hatch out larvae." (F. M. Webster: "Preliminary Report on the Alfalfa Weevil," U. S. Department of Agriculture, Bureau of Entomology Bulletin No. 112, page 21.

COLLECTION OF MATERIAL

Of the 3,335 weevils dissected, the majority were collected in the fall, mainly for the reason that the eggs in question were laid at that time of the year. This resulted in the dissection of more weevils of the new generation than of the old, 2,699 of the former as against 636 of the latter. (See Table 1.)

TABLE 1. NUMBER OF ALFALFA WEEVILS DISSECTED AND MONTH OF COLLECTION

Weevils	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Total
Young..	—	—	3	35	186	228	372	1,069	259	71	333	143	2,699
Old.....	366	109	67	19	53	13	7	2	—	—	—	—	636
Total...	366	109	70	54	239	241	379	1,071	259	71	333	143	3,335

Some of the weevils came from various alfalfa fields in Salt Lake Valley having different types of soil and drainage, and others, referred to as ditch-bank weevils, principally from one large irrigation ditch bank between two alfalfa fields, with a growth of trees, bushes, and weeds, and an accumulation of leaves and sticks—conditions which were apparently suitable for keeping the weevils here for hibernation after they once gathered in late summer.

Various methods of collection were used. Many field weevils were swept from the foliage with insect nets, a few were picked by hand from the ground and from alfalfa crowns, and still others were taken from miscellaneous alcoholic collections made in the course of other experiments. Ditch-bank weevils were obtained chiefly by digging up and screening the surface soil, leaves, and weeds and examining this material in a warm room at the laboratory.

METHOD OF DISSECTION

The beetles, collected as related above, were removed, several at a time, from the alcohol in which they had been preserved, and dissected under a binocular microscope with magnifications ranging from 10 to 15 diameters for ordinary work to 65 diameters for the more minute operations. Each female was partly imbedded, dorsal side up, in paraffin in a shallow watch-glass and covered with 30 per cent alcohol, often with a drop or two of glycerine added. After the removal of the wing covers and wings the abdominal terga were slit with a small scalpel and thrown back, partly exposing the reproductive organs imbedded in the yellowish fat bodies and in the coils of the intestines and the Malpighian tubules (*M*, *M*, figs. 49 and 51). If the reproductive organs were hidden because of their minuteness, their dried-up condition or the quantity of enclosing fat, or if they were to be removed for mounting or drawing, the surrounding structure was carefully torn away with finely sharpened needles. For the usual dissection, however, not much more than a glance at the oviducts was necessary to determine the stage of development. (Fig. 49.)

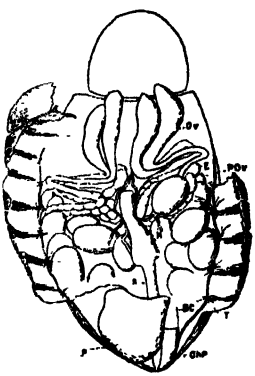


FIG. 49. Dorsal view of alfalfa weevil showing organs in situ.

DESCRIPTION OF FEMALE REPRODUCTIVE ORGANS

Each *ovary* (*Ov*) consists of two *ovarian tubules*, suspended at the anterior end by a branched filament from the tergum of the mesothorax, and passing at the posterior end into a common *paired oviduct* (*POv*), which in turn unites with the oviduct of the opposite side of the body in the *unpaired oviduct* (*UOv*, figs. 50, 51, and 52), or vagina.

The position of the ovaries is dorsal, and the course of the oviducts is generally downward toward the ventrally situated unpaired oviduct, after which the remainder of the tract returns toward the dorsal side.

The unpaired oviduct opens upward into the ventral side of the *bursa copulatrix* (*BC*), a broad, muscular pouch which is attached on its ventral side to the *spiculum ventrale* (*SV*. fig. 51) and by its dorso-posterior wall to a triangular plate lying under the *pygidium* (*P*, fig. 51.) The bursa opens to the exterior, the opening (*OB*, fig. 51) passing between the tips of the heavily chitinized lateral portions (*ChP*) of the triangular plate and below its membranous median portion. (Fig. 51.)

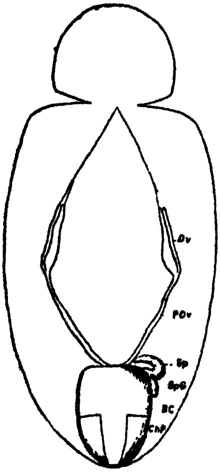
Near the entrance of the unpaired oviduct into the bursa copulatrix and dorsad of it is the opening of the *spermathecal duct* (*SpD*, figs.

50 and 51), a slender tube leading from the *spermatheca* (*Sp*, figs. 50 to 51), a curved, dark-brown, chitinized pouch lying on the right (or occasionally on the left) of the bursa. To the spermatheca is appended the *spermathecal gland* (*SpG*, figs. 50 to 52), a tough, semitransparent, oval vesicle with tapered ends.

The parts most useful in determining the stage of ovulation are the ovarian tubules and the paired oviducts. The former consist each of a cylindrical *terminal chamber* of comparatively homogeneous appearance, in which both ova and nutritive cells arise, and a tubular portion or egg-tube of smaller diameter and walled with parietal cells, down which the ova, or eggs (*E*, *E*, figs. 49 and 52 to 54), pass toward the oviduct. As the weevils mature the tubular portion becomes long and involved, with the developing ova giving the appearance of segmentation, and the paired oviducts, after full-size eggs pass into them, become greatly distended.

Stages of Ovulation

With respect to ovarian development the 3,335 female weevils dissected fell into five somewhat arbitrarily designated stages.



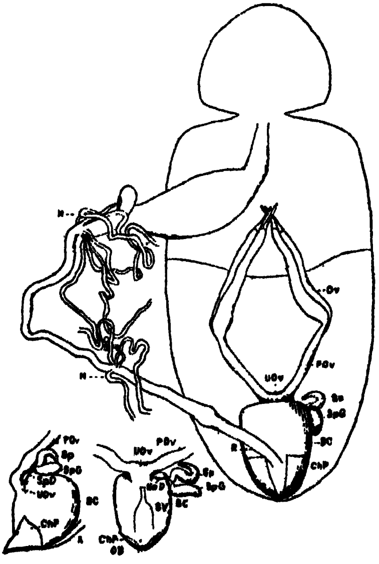
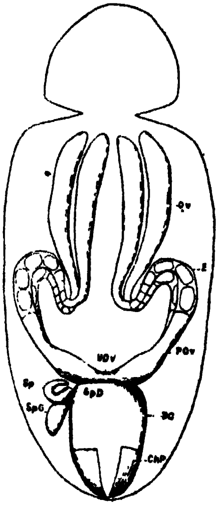


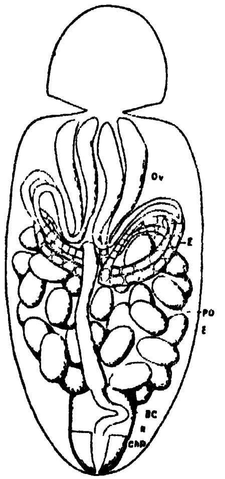
Fig. 50. Diagrammatic representation of female reproductive organs of the alfalfa weevil in "small" stage of ovulation

Fig. 51. Diagrammatic representation of female reproductive organs of the alfalfa weevil in "medium" stage of ovulation.

a. Small stage: Terminal chambers slender, extending about two-thirds of the way to the prothorax; egg-tubes more slender and straight. Paired oviducts also slender; egg-tube and oviduct combined about equal in length to the terminal chamber. (Fig. 50.)

b. Medium stage: Terminal chambers enlarged and extended forward, about four or five times as large as in *a*, but the egg-tubes still short and straight. (Fig. 51.)





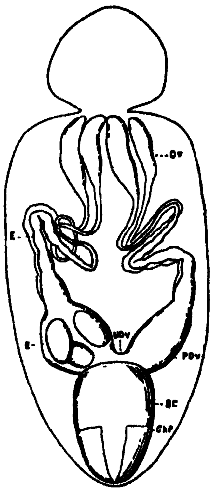


FIG. 52. Diagrammatic representation of female reproductive organs of the alfalfa weevil in "segmented" stage of ovulation.

FIG. 53. Diagrammatic representation of female reproductive organs of the alfalfa weevil in "large" stage of ovulation.

FIG. 54. Diagrammatic representation of female reproductive organs of the alfalfa weevil in "spent" stage of ovulation.

c. Segmented stage: Terminal chambers much enlarged and moved forward nearly to the prothorax; egg-tubes greatly extended and looped outward and forward toward the terminal chambers, with developing ova visible in these portions as beads or segments. Paired oviducts broadened; no full-size eggs. (Fig. 52.).

d. Large stage: Terminal chambers slightly club-shaped anteriorly; egg-tubes looped once or twice in the slender anterior portions and beaded or segmented throughout. Paired oviducts greatly distended and containing one to about forty full-size eggs; body cavity sometimes completely filled with eggs. (Fig. 53.)

e. Spent stage: Terminal chambers more club-shaped, often recurved at tips and shrunken posteriorly; few ova or none in egg-tubes. Paired oviducts, likewise, with few eggs or none, shrunken but broad near the unpaired oviduct as a result of previous distention; little or no fat. (Fig. 54.)

KEY TO ABBREVIATIONS USED IN FIGURES 1 TO 6

BC, bursa copulatrix.	*R*, rectum.
ChP, chitinous plate.	*SpD*, spermathecal duct.
E, *E*, eggs.	*Sp*, spermatheca.
M, *M*, malpighian tubules.	*SpG*, spermathecal gland.
Ov, ovary.	*SV*, spiculum ventrale.
OB, opening of bursa copulatrix.	*T*, tracheae.
P, pygidium	*UOv*, unpaired oviduct.

POv, paired oviduct (in figure 53 stretched membrane of paired oviduct).

GROWTH OF YOUNG WEEVILS

All the young weevils collected during May, June, and July over the three-year period belong to stage *a;* that is, the ovaries showed no growth or striking changes. In August, however, 2 per cent reach stage *b*, in which the ovaries are of medium size with terminal chambers enlarged, and the number remaining in stage *a* is accordingly reduced to 98 per cent. In September the weevils are further advanced, with 5 per cent reaching stage *c*, that is, with segmented ovaries, and 2 per cent, stage *d*, with large ovaries laden with full-size eggs. In other words, of 824 young weevils collected from May to September, inclusive, 6 had fully developed ovaries with mature eggs. In October and November more development takes place, leaving smaller percentages in stages *a* and *b* and larger ones in stages *c* and *d;* in October 8 per cent and in November 27 per cent reach the mature stage. In terms of numbers again, of 1,893 weevils collected from May to October, inclusive, 94 contained full-size eggs, and most of this development came in the last half of October. The exact dates upon which the earliest fully de-

TABLE 2. NUMBERS OF YOUNG ALFALFA WEEVILS EACH MONTH FROM MAY TO NOVEMBER, INCLUSIVE, IN EACH STAGE OF OVULATION

	May	June	July	Aug.	Sept.	Oct.	Nov.
Total Number.....	3	35	186	228	372	1,069	190
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Stage *a*...........	100	100	100	98	81	67	54
Stage *b*...........	0	0	0	2	12	18	15
Stage *c*...........	0	0	0	0	5	7	4
Stage *d*...........	0	0	0	0	2	8	27

veloped ovaries were found in 1913, 1914, and 1915 were, respectively, October 16, October 17, and September 23. The percentage of weevils in each stage of ovulation, together with the numbers dissected, are shown in Table 2.

DIFFERENCE BETWEEN FIELD AND DITCH-BANK WEEVILS

The development for November as indicated in Table 2 would have been greater had not about half of the weevils come from ditch banks and fence rows rather than alfalfa fields. Since ditch-bank weevils mature more slowly, their program of development differs greatly from that of the field weevils.

From November on to spring it was usually impossible to sweep the fields for weevils and it was difficult to obtain them from the ground. On the other hand, it was not so difficult to collect them from hibernating quarters like ditch banks where they often occurred in much greater numbers than in the frozen stubble fields. The weevils collected in this way during 1913 to 1915, and which came from a limited number of ditch banks in the Salt Lake Valley, made up three-fifths of the total number collected and dissected in the fall and winter. It is necessary, therefore, to include them in considering the ovulation during this time of the year. Such weevils were found to have practically no egg-development.

It is not known whether weevils in other localities or in other years congregated in such protected places so abundantly or whether they reached maturity so slowly. The proportion of weevils which spend the fall and winter along ditch banks, fence rows, and places protected by trees, bushes, weeds, and grasses probably depends mainly upon the extent and availability of these places; the beetles happen to fly or crawl there and remain over winter, probably on account of the protection. It is believed to be a large proportion in most localities, and it

TABLE 3. COMPARISON OF FIELD AND DITCH-BANK ALFALFA WEEVILS. SEPTEMBER, OCTOBER, AND NOVEMBER

	From Fields			From Ditch Banks		
	Sept.	Oct.	Nov.	Sept.	Oct.	Nov.
Total number	268	384	103	50	620	83
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Stage *a*	76	22	28	96	92	87
Stage *b*	15	36	14	4	7	13
Stage *c*	7	18	7	0	1	0
Stage *d*	2	24	51	0	0	0

is believed, too, that their slow development is due to an absence of food. Regardless, however, of the extent of such hibernation and the reason for their maturing more slowly than field weevils, the difference here noted should be borne in mind in considering the condition of the weevil population from late summer to early spring. The number of weevils from both fields and ditch banks which were dissected in the fall and their stage of ovulation are shown in Table 3.

GROWTH DURING WINTER

During the winter little egg development takes place since the weevils remain inactive and do not feed except on occasional warm days. Weevils collected in the early spring from both fields and ditch banks were found to be further advanced than those taken in the fall, but such development as does occur may take place during November and March rather than during the midwinter months of December, January, and February. Of a total of 843 weevils collected from November to March inclusive, 63 per cent of those from fields, and none from ditch banks, had mature ovaries laden with eggs (stage *d*), as shown in Table 4.

TABLE 4. CONDITION OF ALFALFA WEEVILS COLLECTED IN WINTER, NOVEMBER TO MARCH

	From Fields		From Ditch Banks	
	Nov. to March	March	Nov. to March	March
Total number......	246	132	597	234
	Per cent	*Per cent*	*Per cent*	*Per cent*
Stage *a*............	15	1	80	65
Stage *b*............	9	7	20	35
Stage *c*............	13	19	0	0
Stage *d*............	63	73	0	0

GROWTH OF OLD WEEVILS DURING SPRING AND SUMMER

Development takes a new start as spring advances. Of 475 weevils collected in March and April, 36 per cent were in stage *d*, while the remainder were less developed. Half of these weevils came from alfalfa fields and of these 72 per cent belonged in stage *d*. Of 132 field weevils in March alone and of 109 in April, 73 per cent and 70 per cent respectively, belonged in stage *d*. This stage also made up 95 per cent of the May and 58 per cent of the June collections, showing that the height of ovulation corresponds with the height of oviposition, as already determined. The July collection shows a great falling off in the development of eggs. Of 53 taken in this month and 13 in August, 70 per cent were found in stage *e*, that is, with few eggs or none in the oviducts and with few or none developing in the egg-tubes. Stage *d* made up the remaining 30 per cent. During the late summer and fall few old beetles have ever been found; all that were collected from 1913 to 1915 were dissected. In September 7 weevils were found and 2 in October, about equally divided between stage *d* and stage *e*. The condition of the old weevils from spring to fall is shown in Table 5.

TABLE 5. NUMBERS OF OLD ALFALFA WEEVILS IN EACH STAGE OF OVULATION EACH MONTH, MARCH TO OCTOBER, INCLUSIVE

	March	April	May	June	July	Aug.	Sept.	Oct.
Total No.	366	109	67	19	53	13	7	2
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Stage *a*....	42	17	0	0	0	0	0	0
Stage *b*....	25	5	0	0	0	0	0	0
Stage *c*. ..	7	8	5	10	0	0	0	0
Stage *d*....	26	70	95	58	30	30	43	50
Stage *e*....	0	0	0	32	70	70	57	50

CONCLUSION

This survey of the growth of a generation of female alfalfa weevils throughout the two seasons of its existence shows that the beetles emerging in the spring and summer remain immature for about four months, at least, after emergence, or until late September and October of their first season. It indicates, too, that about half of them—with the exception of ditch-bank weevils—are capable of oviposition by the time winter sets in; weevils from ditch banks and fence rows were found without eggs even into winter and early spring. On the other hand, the small number of females of the previous season which survive until August and September of their second summer is enough to account for the small number of eggs which are found at that time. These eggs, therefore, and any larvae which come from them, are retarded members of the old generation and not a partial new brood.

The eggs developed and deposited by the beetles maturing in the fall are not likely to produce larvae of importance anywhere in the intermountain country, since the cool temperatures would prevent their hatching in sufficient numbers the same year.

COMPOSITION OF FLUORIDES AND FLUOSILICATES SOLD AS INSECTICIDES

By R. H. Carter and R. C. Roark, *Insecticide Division, Bureau of Chemistry and Soils, Washington, D. C.*

Abstract

Samples of fluorides and fluosilicates representing the products of 14 manufacturers in the United States were examined chemically and microscopically. Both of these materials may be obtained in a satisfactory degree of purity. In solution all the fluosilicates give an acid reaction; whereas the sodium fluorides show a neutral or alkaline value.

It is believed that the observed variations in the apparent toxicity to insects of different brands of commercial sodium fluosilicate are owing to factors other than variations in fluorine content. Variations in size of crystals cause variations in cubic inches per pound, dusting qualities, adhesiveness, and rate of solution, properties which greatly influence the efficacy of a dust insecticide.

Variations in foliage-burning properties of different brands of commercial sodium fluosilicate are likewise probably the result of variations in crystal size.

Introduction

Fluorine compounds have been in use for some time in various industries for such purposes as fluxes in metallurgy, as glazing materials in ceramics, as stone and concrete hardeners, for frosting glass, as disinfectants and antiseptics, as food preservatives, as wood preservatives, and as household insect and rodent poisons.

More recently fluorine compounds have been investigated with regard to their insecticidal action against agricultural insect pests of several kinds, particularly the cotton boll weevil, the Mexican bean beetle, the corn borer, and the sugar cane borer.

Hinds and Spencer (La. Agr. Exp. Sta. Bull. No. 201, 1–56, Aug. 1927) report the results of extensive tests with fluorine compounds for control of the sugar cane borer and the corn borer. The following is quoted from their report (p. 18): "In the course of this work it soon became evident that there exists a very large degree of variation in the qualities, safety and insecticidal value of various brands of materials which may be purchased under the name of 'Sodium silicofluoride.' First of all, there is a great variation in physical texture, in the fineness of particles and in the dusting properties. Field experiments indicated that there may be also a great deal of difference in the chemical composition or at least in the toxic effects to plant foliage and to insect stages, of different brands of sodium silicofluoride materials. There is also distinct evidence of a difference in toxicity to the borer between solutions from various brands of sodium silicofluoride material."

In the belief that a chemical and physical examination of the various fluorine compounds sold commercially as insecticides would throw some light on these variations and perhaps open new fields for the insecticidal use of these compounds, we obtained samples of commercial materials and analyzed them to determine the principal constituents. A preliminary microscopic examination of all samples was made.

We wish to extend our thanks to G. L. Keenan of the Food, Drug and Insecticide Administration for microscopic and microchemical tests. We also wish to thank those manufacturers who kindly supplied samples of their products and information as to their uses and methods of manufacture and analysis.

METHODS OF ANALYSIS

In general, the methods of analysis used were those recommended by Scott, "Standard Methods of Chemical Analysis," 4th edition.

Sodium fluoride determinations were made by gravimetric procedure, which included final precipitation and weighing as calcium fluoride.

The fluosilicate determinations were made volumetrically by titration in platinum dishes with standard silica-and-carbonate-free-sodium hydroxide, phenolphthalein being used as indicator.

Moisture was determined by drying the sample at 110° C. for three hours.

The bifluorides were determined as follows: 0.5 g. of the sample was weighed into a 100 cc. platinum dish, 1.0 g. of solid potassium chloride was added and the whole was dissolved in 25 cc. of water; 20 cc. of neutral alcohol was then added. After this mixture was cooled to approximately 0° C., it was titrated with standard silica-and-carbonate-free-sodium hydroxide, phenolphthalein being used as the indicator, until the red color remained for one minute.

The quantity of carbon dioxide was determined by liberating the carbon dioxide by dilute acid and subsequently evolving and absorbing it by barium hydroxide solution under reduced pressure. (J. R. I. Hepburn, Analyst, vol. 51, pp. 622-24, 1926.) A back titration of the excess baryta was then made against standard oxalic acid, phenolphthalein being used as indicator. The results are calculated to sodium carbonate.

The pH values were determined colorimetrically, a La Motte hydrogenion comparator and set of standards and indicators being used. The pH values were determined on solutions less than saturated rather than on saturated solutions, to minimize the effects of impurities which might be present. $\mathrm{pH} = \log \frac{1}{(\mathrm{H})+}$. Discussion of pH values may be found in standard texts on that subject, but it may be stated here that pH values below 7 indicate an acid solution and those above 7 indicate an alkaline solution.

The determination of cubic inches per pound is at best rather unsatisfactory, and the methods are all arbitrary. A glass cylinder of known capacity was filled by allowing the powder to run through a funnel at a definite height above the cylinder and centered over it. When the cylinder was filled to overflowing the material was leveled off, and its weight was determined. The number of cubic inches per pound was calculated from the weight of material occupying a known volume. Neither the funnel nor the cylinder was tapped during the determination. Fairly close checks could be obtained on the same material, and the results on different materials are, therefore, comparable.

Qualitative tests for chlorides and sulphates were made in the usual way.

SODIUM FLUORIDE

(See Table 1).

Microscopical Examination

K-201—"Caked" in container; doubly refracting material present. Microchemical tests identified chloride, carbonate, sulphate, and calcium.

K-202—Tendency to "cake" in container; doubly refracting material evident. Carbonate, chloride, calcium, and sulphate identified microchemically; large crystals.

K-203—"Caked" in container; very small crystals; doubly refracting material present; calcium, sulphate, chloride, and carbonate identified microchemically.

K-200—Relatively large crystals and a small quantity of doubly refracting material. Calcium, carbonate, sulphate, and chloride identified microchemically.

K-199—Rather small crystals. Microchemical tests identified calcium, sulphate, chloride, and carbonate.

K-185—Relatively small crystals. Positive microchemical tests obtained for calcium, chloride, carbonate, and sulphate.

K-189—Relatively small crystals in part, large crystals not so numerous. Sulphate, calcium, chloride, and carbonate identified microchemically.

TABLE 1. ANALYSES OF SAMPLES OF COMMERCIAL SODIUM FLUORIDE.

Lab. No.	Manufacturer and name of product	Total fluorine (F)	Sodium fluoride (NaF)	Sodium bifluoride (NaFHF)	Sodium fluosilicate (Na_2SiF_6)	Sodium carbonate (Na_2CO_3)	Moisture	Other constituents by difference	pH of 2% solution	Cu. In. per Lb.
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*		*Cu. In.*
K-201	Manufacturer A, Sodium Fluoride, 90% Light. .	40.9	90.5	0.00	0.00	2.90	0.12	6.5	10.4	39.5
K-202	Manufacturer A, Sodium Fluoride, 90% Heavy.	40.7	90.0	0.00	0.00	3.70	0.11	6.2	10.3	27.7
K-203	Manufacturer A, Sodium Fluoride, 95% Light. .	42.7	94.6	0.00	0.00	0.80	0.05	4.5	9.1	44.6
K-200	Manufacturer A, Sodium Fluoride, 95% Heavy.	42.9	94.9	0.00	0.00	0.55	0.15	4.4	7.3	21.9
K-199	Manufacturer B, Sodium Fluoride.	43.9	94.8	0.02	1.77	0.25	0.06	3.1	6.9	51.2
K-185	Manufacturer C, Sodium Fluoride "Fluffy". . . .	43.5	95.9	0.04	0.22	0.39	0.14	3.3	7.3	35.4
K-189	Manufacturer D, Sodium Fluoride 95–97%.	42.7	94.5	0.02	0.00	1.72	0.51	3.3	9.0	36.4
K-191	Manufacturer E, Sodium Fluoride.	44.9	98.8	0.04	0.37	0.00	0.34	0.4	7.1	38.4
K-187	Manufacturer F, Sodium Fluoride.	40.3	89.2	0.00	0.00	4.39	1.02	5.4	10.5	35.0
K-207	Manufacturer G, Sodium Fluoride "Fluffy". . . .	43.1	95.3	0.00	0.08	0.29	0.23	4.1	7.3	36.4
K-192	Manufacturer H, Sodium Fluoride, Purified. . . .	43.8	96.2	0.00	0.50	0.60	0.17	2.5	7.1	36.8
K-195	Manufacturer I, Sodium Fluoride.	40.9	90.6	0.00	2.17	0.31	0.04	6.9	6.8	37.3

K-191—Uniformly small crystals. Microchemical tests obtained for carbonate, calcium, chloride, and sulphate.

K-187—Crystalline sodium fluoride, also a small quantity of doubly refracting material. Microchemical tests obtained for chloride, calcium, carbonate, and sulphate.

K-207—Large crystals; silica also detected; sulphate, carbonate, chloride, and calcium identified microchemically.

K-192—Largely small crystals; some hexagons of sodium fluosilicate. Calcium, chloride, carbonate, and sulphate identified microchemically.

K-195—Uniformly small crystals; a small quantity of doubly refracting material. Carbonate, calcium, sulphate, and chloride identified microchemically.

Twelve samples of sodium fluoride were examined. They were all finely divided powders, ranging in sodium fluoride (NaF) content from 90 to 99 per cent. Nearly all contained sodium carbonate or some other carbonate in different quantities, and some contained sodium fluosilicate also. Small quantities of bifluorides were also found in some samples, and the moisture was low in all. Chlorides and sulphates were detected chemically and microscopically, and calcium in some combination was present.

There was considerable range in the pH value of solutions that contained 2 g. per 100 cc. of water, but all were neutral or alkaline. A concentration of 2 g. per 100 cc. of water was chosen as representing approximately a half saturated solution. It was thought that this concentration rather than a saturated solution would give a better comparison of the different brands of sodium fluoride.

The number of cubic inches per pound is fairly uniform and averages considerably higher than for the sodium fluosilicates. Most of these materials were composed of small crystals, and "caking" in the containers was evident in some cases.

Two methods of preparation of sodium fluoride are in general use: (1) The neutralization of hydrofluoric acid by sodium hydroxide or sodium carbonate ($HF + NaOH = NaF + H_2O$); (2) the treatment of sodium carbonate or sodium hydroxide with a solution of sodium fluosilicate, hydrofluosilicic acid, or fumes of silicon tetrafluoride at elevated temperatures in order to convert the sodium fluosilicate into sodium fluoride. Unless it is purified further, the product made by this process contains considerable silicic acid.

$$Na_2SiF_6 + 2Na_2CO_3 + 2H_2O = 6NaF + Si(OH)_4 + 2CO_2.$$

SODIUM FLUOSILICATE

TABLE 2. ANALYSES OF SAMPLES OF COMMERCIAL SODIUM FLUOSILICATE.

Lab. No.	Manufacturer and name of product	Total fluorine (F) *Per cent*	Sodium fluosilicate (Na_2SiF_6) *Per cent*	Sodium bifluoride (NaFHF) *Per cent*	Moisture *Per cent*	Other constituents by difference *Per cent*	pH of 0.5% solution	Cu. In. per Lb. *Cu. In.*
K-188	Manufacturer J, Sodium Fluosilicate, "Fluo"	58.0	96.0	0.09	0.06	3.8	3.1	24.7
K-186	Manufacturer I, Sodium Silicofluoride	59.1	97.9	0.09	0.05	2.1	3.1	22.6
K-183	Manufacturer K, Sodium Fluosilicate No. 1	60.3	99.8	0.04	0.02	0.14	3.1	24.2
K-184	Manufacturer K, Sodium fluosilicate No. 2	58.5	98.6	0.04	0.03	1.3	3.1	28.5
K-197	Manufacturer K, Sodium fluosilicate No. 3	59.7	98.9	0.14	0.10	0.86	3.1	24.5
K-204	Manufacturer L, Sodium Fluosilicate	58.9	97.5	0.02	0.04	2.4	3.1	25.4
K-206	Manufacturer D, Sodium Silicofluoride	57.1	94.4	0.04	0.05	5.5	3.1	24.7
K-205	Manufacturer E, Sodium Silicofluoride	59.7	98.8	0.02	0.05	1.1	3.1	23.6
K-193	Manufacturer G, Sodium Silicofluoride	58.8	97.3	0.13	0.21	2.4	3.1	27.1
K-198	Manufacturer F, Sodium Silicofluoride	58.8	97.4	0.09	0.05	2.5	3.1	24.9
K-182	Manufacturer H, Sodium Silicofluoride	59.1	97.9	——	0.04	2.1	3.1	22.6

Microscopical Examination

K-188—Relatively large crystals, and in so far as microscopical examination could determine, appears to be essentially uniform.

K-186—Essentially uniform; relatively large crystals.

K-183—Medium-sized crystals; appears to be essentially uniform.

K-184—Medium-sized crystals; essentially uniform with the exception of a small quantity of silica.

K-197—In so far as microscopical examination could determine, essentially uniform; relatively large crystals.

K-204—Essentially small and large crystals.

K-206—Large and small crystals, also an appreciable quantity of silica.

K-205—Essentially uniform; large crystals.

K-193—Essentially uniform, in so far as microscopical examination could determine; large crystals.

K-198—Uniformly large crystals.

K-182—Relatively large hexagonal crystals; appears to be essentially uniform.

Eleven samples of commercial sodium fluosilicate were analyzed and found to contain from 95 to 99 per cent sodium fluosilicate (Na_2SiF_6). Nearly all contained small quantities of bifluorides, and the moisture content was low. Chlorides and sulphates, as well as some silica, were present, and some samples contained diatomaceous earth. Sodium fluoride as such was not determined, but it was probably present in small quantities.

The pH values of the solutions of 0.5 g. per 100 cc. uniformly showed an acid condition. This concentration was below the saturation point, but the same phenomenon was observed with mixtures of 2 g. per 100 cc. which is above the solubility of sodium fluosilicate. A pH value indicating an acid condition was noticed in all fluosilicate solutions, even the special mixtures containing appreciable quantities of carbonate. From this, it appears that the addition of alkali, such as sodium carbonate or hydrated lime, to dilute the mixture and to neutralize the acidity serves rather to react with and decrease the quantity of sodium fluosilicate after these compounds go into solution.

$$Na_2SiF_6 + 2Na_2CO_3 + 2H_2O = 6NaF + Si(OH)_4 + CO_2$$
$$Na_2SiF_6 + 2Ca(OH)_2 = 2NaF + 2CaF_2 + Si(OH)_4$$

Calcium compounds also remove some of the fluorine from solution as the insoluble calcium fluoride. Sodium fluosilicate is lower in cubic inches per pound than sodium fluoride.

Methods of manufacture of sodium fluosilicate and the fluosilicates in general vary. All of them, however, are based on the reaction between hydrofluoric acid and silica, which forms silicon tetrafluoride. This may be absorbed by water and the resulting hydrofluosilicic acid treated with a salt or hydrate of the desired base, or the silicon tetrafluoride may be absorbed directly by a solution of a salt of the base, thereby forming the fluosilicate.

$$4HF + SiO_2 = SiF_4 + 2H_2O$$
$$3SiF_4 + 2H_2O = 2H_2SiF_6 + SiO_2$$
$$H_2SiF_6 + 2NaCl = Na_2SiF_6 + 2HCl$$
$$3SiF_4 + 4NaCl + 2H_2O = 2Na_2SiF_6 + SiO_2 + 4HCl$$

As silicon tetrafluoride is a by-product in the manufacture of fertilizer from phosphate rock, nearly unlimited quantities are available for the manufacture of either the fluosilicates or the fluorides.

MISCELLANEOUS FLUORINE COMPOUNDS

(See Table 3).

Microscopical Examination

K-215—Small, granular crystals; appears to be essentially uniform in character; magnesium identified microchemically.

K-213—Appears to be essentially a uniform product; magnesium identified microchemically.

K-214—Appears to be essentially uniform; large crystals; magnesium identified microchemically.

K-212—Appears to be essentially uniform; magnesium identified microchemically.

K-210—Appears to be uniformly crystalline; microchemical tests obtained for calcium, carbonate, sulphate.

K-219—Not uniform in composition; contains crystalline copper sulphate ($CuSO_4.5H_2O$); microchemical tests obtained for copper, sulphate, and fluoride.

K-216—Not uniform in composition. Microchemical tests obtained for copper, sodium, and sulphate.

K-208—Not uniform in composition; contains small, doubly refracting needles, also hexagons resembling sodium fluosilicate. Microchemical tests obtained for barium, sodium, chloride, and carbonate.

K-211—Appears to be essentially uniform in so far as microscopical examination could determine; barium and carbonate identified microchemically.

TABLE 3 ANALYSES OF MISCELLANEOUS FLUORINE COMPOUNDS

Lab. No.	Manufacturer and name of product	Total fluorine (F)	Purity	Moisture	Other constituents	pH of 0.5% solution
		Per cent	*Per cent*	*Per cent*	*Per cent*	
K-215	Manufacturer C, Magnesium Silicofluoride	41.8	100.7	—	—	3.1
K-213	Manufacturer D, Magnesium Silicofluoride	41.9	100.9	—	—	3.0
K-214	Manufacturer H, Magnesium Silicofluoride, "Masif"	41.7	100.6	—	—	3.1
K-212	Manufacturer I, Magnesium Silicofluoride	41.5	100.1	—	—	3.1
K-210	Manufacturer L, Calcium (lime) Fluosilicate	33.4	53.4	0.88	—	3.4
K-219	Manufacturer H, Copper Fluosilicate	35.6	98–99*	—	—	3.3
K-216	Manufacturer H, Copper Fluoride	24.3	65–66*	—	alkali salts and water*	—
K-208	Manufacturer H, Barium Fluoride	—	85*	0.04	$BaSO_4$, 10* $BaSiF_6$, 5	4.2
K-211	Manufacturer I, Barium Fluoride	—	—	0.03	—	4.0
K-218	Manufacturer H, Synthetic Cryolite	—	98–99*	0.08	silica, 1*	4.1
K-209	Manufacturer D, Cryolite	—	—	0.12	—	4.4

*Manufacturer's figure.

K-218—Appears to be essentially uniform in so far as microscopical examination is concerned; microchemical tests also obtained for sodium and aluminum.

K-209—Amorphous and essentially uniform in character in so far as microscopical examination is concerned; microchemical tests also obtained for sodium and aluminum.

Several different fluorine compounds were obtained and examined. The magnesium fluosilicates were all crystalline compounds of a high degree of purity. This compound contains six molecules of water of crystallization, but begins losing some even at room temperature, which accounts for an apparent content of over 100 per cent. $MgSiF_6 \cdot 6H_2O$.

The other materials are of a relatively high degree of purity, but have not received much attention as insecticides.

SPECIAL MIXTURES AND DUSTING POWDERS

(See Table 4).

Microscopical Examination

K-190—Medium-sized crystals of sodium silicofluoride, also an appreciable quantity of diatomaceous earth.

K-194—Relatively large crystals of sodium silicofluoride and an appreciable quantity of diatomaceous earth.

K-217—Inflated, balloon-like structures which are singly refracting in character. Microchemical tests obtained for calcium and phosphate.

K-196—Not uniform in composition; sodium silicofluoride, sodium fluoride, and borax identified.

Six of the samples of dusting powders containing sodium fluosilicate were received from J. W. Ingram, Crowley, Louisiana. Some of these evidently contained lime or hydrated lime, whereas others contained diatomaceous earth. In most respects they were similar to some of the commercial fluosilicate dusting powders on the market. Here again it is noticed that solutions of the fluosilicates have an acid pH value even though carbonates or hydrated lime have been mixed with them. The increased efficiency of these compounds after a lapse of time noticed by several investigators might have been due to the reactions which took place after solution had been effected.

SUMMARY

The following summary is based on the chemical and microscopical examination of 12 samples of sodium fluoride, 11 of sodium fluosilicate, 4 of magnesium fluosilicate, 1 of calcium fluosilicate, 1 of copper fluo-

TABLE 4. ANALYSES OF SPECIAL MIXTURES AND DUSTING POWDERS.

Lab. No.	Manufacturer and name of product	Total fluorine (F)	Sodium fluosilicate (Na_2SiF_6)	Sodium carbonate (Na_2CO_3)	Moisture	Insoluble	Other constituents by difference	pH of 0.5% solution	Cu. In. per Lb.
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*		*Cu. In.*
	Field Sample No. 1	53.9	89.2	0.0	0.24	9.8	1.0	3.4	26.8
	Field Sample No. 2	48.7	80.5	0.0	0.47	17.2	2.3	3.2	61.4
	Field Sample No. 3	51.5	85.1	0.0	0.42	16.5	—	3.3	33.3
	Field Sample No. 4	44.0	72.8	0.0	1.10	24.9	2.3	3.3	43.2
	Field Sample No. 8050	31.4	51.9	1.4	2.0	37.8	6.9	4.1	42.5
	Field Sample No. 8055	31.1	51.5	1.0	2.20	36.8	8.5	4.1	42.5
K-190	Manufacturer H, Light Dusting Powder, Sodium Fluosilicate	51.5	85.2	0.28	0.74	—	14.8	3.4	26.6
K-194	Manufacturer H, Extra Light Dusting Powder, Sodium Fluosilicate	43.4	71.8	0.26	0.94	—	28.2	3.2	43.2
K-217	Manufacturer M, Calcium Fluosilicate Compound	—	—	0.23	8.46	—	—	4.4	98.8
K-198	Manufacturer D "Fluorex"	—	—	—	4.06	—	—	4.0	28.5

silicate, 2 of barium fluoride, 2 of cryolite, 1 of copper fluoride, and 6 of dusting mixtures containing sodium or calcium fluosilicate. These samples are representative of fluorine compounds sold for insecticidal purposes by 14 manufacturers in the United States in November, 1927.

1. Sodium fluoride and sodium fluosilicate may be obtained commercially in a very satisfactory degree of purity.
2. The impurities found are only such as would be expected from the methods of manufacture.
3. The samples of commercial sodium fluoride are higher in cubic inches per pound than those of sodium fluosilicate.
4. All the fluosilicates in solution show an acid pH value even though they contain carbonates, whereas the sodium fluorides show a neutral or alkaline pH value. This acidity may account in some degree for the burning of foliage, which has often been observed when fluosilicates are applied.
5. The addition of a small quantity of hydrated lime or sodium carbonate to fluosilicates to decrease the acidity serves rather to decompose some of the fluosilicate in solution to the fluoride without raising the pH value of the solution. It is also pointed out that lime precipitates the fluorine as insoluble calcium fluoride when it comes in contact with a solution containing fluorine.
6. The size of the crystals is a factor which affects their rate of solution, and, therefore, the time elapsing from application until insecticidal action is manifested. Size of crystals also influences the effectiveness with which the material may be applied as a dust, as well as its sticking qualities.
7. Several other fluorides, such as barium fluoride and cryolite, are available in a high degree of purity.
8. Other fluosilicates, such as those of magnesium, copper, and calcium, are available in a relatively pure condition.
9. The number of cubic inches per pound of these compounds is small compared to calcium arsenate and other good dusting powders, but no doubt lighter products can be made.
10. It is believed that the observed variations in the apparent toxicity to insects of different brands of commercial sodium fluosilicate are owing to factors other than variations in fluorine content. Variations in size of crystals cause variations in cubic inches per pound, dusting qualities, adhesiveness, and rate of solution, properties which greatly influence the efficacy of a dust insecticide.
11. Variations in foliage-burning properties of different brands of commercial sodium fluosilicate are likewise probably the result of variations in crystal size.

AN OPERATION IN PRACTICAL CONTROL OF CODLING MOTH IN A HEAVILY INFESTED DISTRICT—SECOND REPORT

By THOMAS J. HEADLEE, PH.D., *Entomologist, New Jersey Agricultural Experiment Stations*[1]

ABSTRACT

Continuance of the organized efforts of growers against the codling moth, *Carpocapsa pomonella*, in the Glassboro district has resulted in a further material increase in fruit free from injury by that insect. In 1925 the growers who form this organization picked 50% of their total fruit free from codling moth injury, in 1926 they picked 68.8% free, and in 1927 they picked 82.1% free. The timing, composition and methods of applying insecticide materials are the dominant factors in obtaining this result but orchard sanitation measures, such as proper disposal of used baskets, scraping rough-barked trees, and the use of burlap bands, play a minor but important part in obtaining this result.

INTRODUCTION

This paper gives an account of the results of the second year of organized effort against the codling moth in the vicinity of Glassboro, N. J. The report of the first year's work was published in the JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 20, No. 1, February 1927.

GENERAL PROCEDURE

The organization mentioned in the first report was continued. Two additional growers joined the group and one dropped out, his property becoming the check orchard. This check orchard received about two treatments, possibly some parts three, but no spray was applied to it until the overwintered brood of moths started to fly. This left a total of twelve properties in the operation. The arrangement between the growers and the Experiment Station was in 1927 precisely that which obtained in 1926.

In orchards of this group in which eggs of apple aphids were apparently absent, the trees were treated at delayed dormant with oil emulsion four and a half gallons to ninety-five and a half gallons of water. In other orchards in which the eggs of apple aphids were present, especially if the trees concerned were large, the delayed dormant treatment was composed of one part of commercial lime sulfur to nine parts of water plus 40% nicotine one to five hundred.

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[1] Paper No. — of the Journal Series of the New Jersey Agricultural Experiment Stations, Department of Entomology.

The pink bud spray consisted of commercial lime sulfur 1–40. In accordance with the demand of local conditions, some of these orchards were sprayed with the above mixture of commercial lime sulfur to which lead arsenate had been added at the rate of one and a half pounds to fifty gallons and some were sprayed with the lime sulfur alone.

The blossom fall spray consisted generally of New Jersey Dry Mix and lead arsenate according to the usual formula but in some instances commercial lime sulfur 1–40 was used in the place of the dry mix, and in one instance, at least, the lead arsenate was omitted from this spray. Because no later notice will be taken of the results of this last procedure it should be said at this point that the amount of codling moth injury in the block receiving no arsenic at the blossom fall was not appreciably greater than it was in the blocks where the arsenate of lead was applied at the blossom fall. Where New Jersey Dry Mix was used for this spray, enough additional sticker was incorporated to give a total of three pounds to one hundred gallons of spray.

The seven day after blossom fall treatment consisted of New Jersey Dry Mix and arsenate of lead at the usual formula, except that enough additional sticker was included to bring the total amount up to three pounds to one hundred gallons.

The seventeen day after blossom fall treatment in most of the orchards consisted of New Jersey Dry Mix and arsenate of lead of the usual formula but in others, where heavy codling moth injury was anticipated, the amount of arsenate of lead was increased to two pounds of the powder, or its equivalent, to fifty gallons of spray. In all cases the additional sticker was incorporated in this spray.

It developed, before the application of the seventeen day after blossom fall spray, that that spray would prove the first cover spray for codling moth. On early fruit the seventeen day spray was the last one given in some of the orchards, the additional treatments for the first brood of larvae being made through the medium of a duster, using split applications of a sulfo-arsenical mixture consisting of 85% elemental sulfur and 15% powdered lead arsenate. In some instances a later cover spray was given to early fruit and, in such instances, the amount of arsenate of lead was reduced to one and one-half pounds to fifty gallons and no sticker additional to that which was already in the dry mix was incorporated.

On late apples the later cover sprays for the larvae of the first brood consisted of New Jersey Dry Mix, powdered lead arsenate two pounds to fifty gallons, and enough additional sticker to increase the total to three pounds to one hundred gallons of spray mixture. These later cover sprays, of which in some instances there was one and in other instances two, were applied as soon as the film coating established by the seventeen day spray had been broken.

Some of the orchards received one film coating cover spray for the second brood and others received two, while still others received none. Where one cover spray for the second brood of larvae was given it consisted of a reduced amount of dry mix, lead arsenate powder two pounds to fifty gallons of spray mixture, and enough additional sticker to make a total of three pounds to one hundred gallons of spray. The second cover spray was applied when the film coating established by the first was broken and consisted of a reduced amount of dry mix, one and one-half pounds of powdered lead arsenate, or its equivalent, to fifty gallons and no additional sticker whatever.

RESULTS OF THE 1927 TREATMENTS

The results of the 1927 treatments against the codling moth in the orchards of this group of growers are set forth in Table No. 1.

Examination of Table No. 1 serves to show that these twelve growers on 73,400 trees on 1,401 acres produced a crop of 370,704 bushels of apples of which 304,629.3 bushels or 82.1% were free from codling moth injury and all injury similar to codling moth injury. Further examination of Table No. 1 will serve to show that these results were obtained in the face of a codling moth activity sufficient, in a single season, to infest 84% of the total fruit in an orchard which received two or three sprays applied after the moths of the overwintered generation had begun to fly. In some parts of this orchard the late fruit showed an average of 3.27 worm holes per fruit. It is of further interest to know that this particular orchard in 1926 showed 70% of its fruit at picking time absolutely free from codling moth injury of any kind.

In summarizing the effect of this effort against the codling moth from its beginning, it may be said that in 1925 this group of growers picked 50% of the crop of apples free from codling moth injury, in 1926 this group picked 68.8% free from codling moth injury, and in 1927 this group picked 82.1% free from codling moth injury of all kinds.

The work of the years 1926 and 1927 shows: (1) that the timing, the composition, and the method of applying insecticidal applications forms the overwhelmingly dominant factor in obtaining these increases in clean fruit; (2) that the timing can be done by the use of the codling moth emergence boxes combined with the codling moth bait pans, that the materials used should fit the local conditions of infestation, and

TABLE 1. RESULTS OF 1927 TREATMENTS AGAINST THE CODLING MOTH

Orchard No.	Acreage	No. of trees	Trees, height, width	Number of sprays				Scraping		Banding		Yield in bushels								Per cent free from C. M. injury					
				Early		Late						Early			Late			Total							
				Total	C. M.*	Total	C. M.	Needed	Used	Needed	Used	Total	Clean	%	Total	Clean	%	Total	Clean	1925	1926	Gain	1927	Gain	Total Gain
1	210	9,400	25x25	6	3	8	5	Yes	Yes	Yes	Yes	6,777	6,099.0	90.0	40,987	30,084.0	73.4	47,764	36,183.0	50.0	67.0	17.0	75.7	8.7	25.7
2	25	700	25x30	5	3	8	5	Yes	No	Yes	?	1,800	1,692.0	94.0	1,600	688.0	43.0	3,400	2,380.0	25.0	40.0	15.0	70.0	30.0	45.0
2A	25	700	12x15	-	-	8	6	No	No	No	Yes	—	—	—	7,450	6,720.0	90.2	7,450	6,720.0	40.0	85.0	45.0	90.2	5.2	50.2
3	100	5,000	25x30	6	3	9	6	Yes	No	Yes	No	4,000	3,400.0	85.0	36,390	24,235.7	66.0	40,390	27,635.7	45.0	60.0	15.0	68.4	8.4	23.4
3A	30	1,500	20x25	6	3	8	5	Yes	No	Yes	No	—	—	—	10,963	7,125.9	65.0	10,963	7,125.9	50.0	75.0	25.0	64.9	10.1	14.9
5	15	1,200	12x15	6	3	8	5	No	No	Yes	Yes	—	—	—	6,310	5,902.6	93.5	6,310	5,902.6	45.0	85.0	40.0	93.5	8.5	48.5
6	60	3,000	20x25	5	3	6	4	Yes	No	Yes	Incom.	2,600	2,548.0	98.0	15,950	13,798.0	86.5	18,550	16,346.0	60.0	85.0	25.0	88.1	3.1	28.1
7	15	900	16x20	6	3	8	5	No	No	Yes	Yes	42	39.9	95.0	3,021	2,657.6	87.8	3,063	2,697.5	60.0	90.0	30.0	88.0	2.0	28.0
8	400	15,000	20x25	6	3	7	5	Yes	Yes	Yes	Yes	33,952	33,442.7	98.2	49,356	36,079.2	73.8	83,308	69,521.9	35.0	50.0	15.0	83.4	33.4	48.4
9	80	3,850	20x25	6	3	8	5	Yes	No	Yes	No	12,000	11,400.0	95.0	22,840	17,472.6	76.5	34,840	28,872.6	39.0	75.0	36.0	82.8	7.8	43.8
10	40	1,800	22x28	6	3	7	4	Yes	Yes	Yes	Yes	1,700	1,683.0	99.0	14,706	12,568.9	85.4	16,406	14,251.9	75.0	80.0	5.0	86.8	6.8	11.8
10A	50	3,000	25x30	6	3	7	4	Yes	Yes	Yes	Yes	7,700	7,623.0	99.0	19,385	18,374.9	94.2	27,085	25,997.9	80.0	95.0	15.0	95.9	0.9	15.9
11	276	25,000	12x15	-	-	4	3	No	No	No	No	—	—	—	35,900	34,196.0	95.2	35,900	34,196.0	60.0	97.0	37.0	95.2	1.8	35.2
12	25	750	20x25	6	3	7	4	Yes	Yes	Yes	Yes	3,000	2,400.0	80.0	8,768	4,235.0	48.6	11,768	6,635.0	—	—	—	56.3	—	—
12A	20	800	12x14	6	3	7	4	No	No	No	No	2,200	2,156.0	98.0	2,747	2,080.5	72.9	4,947	4,236.5	—	—	—	85.6	—	—
13	30	800	25x30	6	3	6	3	Yes	No	Yes	No	2,800	2,716.0	97.0	15,760	13,210.8	83.0	18,560	15,926.8	—	60.0	—	85.8	25.8	25.8
Totals	1,401	73,400										78,571	75,199.6	95.7	292,133	229,429.7	78.5	370,704	304,629.3	50.0	68.8	18.8	82.1	13.3	32.1
Check	35	2,000	16x18	-	-	3	3	Yes	No	Yes	No	950	807.5	85.0	6,900	448.5	0.65	7,850	1,256.0	40.0	70.0	30.0	16.0	54.0	—

*C. M. = Codling moth.

that the methods of application should be such as to result in film coating of all sides of the fruit and of the upper and lower surfaces of the leaves; (3) that orchard sanitation measures, such as disposal of used baskets, scraping rough-barked trees, and the employment of burlap bands play a minor but important part in securing these results; (4) that the use of the scraper is unnecessary on young, smooth-barked trees and that the employment of the burlap band is likewise unnecessary on these trees, except as they stand adjacent to or among trees having very heavy infestation of codling moth.

THE EUROPEAN CORN BORER CLEAN-UP CAMPAIGN IN NEW YORK STATE, 1927

By M. D. LEONARD, *Ithaca, N. Y.*

ABSTRACT

During the spring of 1927 a compulsory clean-up campaign against the European Corn Borer, *Pyrausta nubilalis*, was carried out in a section including parts of three counties in Western New York. Preparatory to the spring clean-up a comprehensive educational campaign was put on thruout the whole of the more heavily infested part of the State. The organization and methods employed in this educational campaign are herein briefly described, the area under regulation is delimited and the policies involved explained.

In February 1927 the United States Congress passed a bill appropriating ten million dollars for the control of the European Corn Borer. This was undoubtedly the largest single sum ever appropriated for the control of an injurious insect. The money became available on March 15, 1927 and there was at once set in motion a vast machinery organized and operated with almost military precision. A true war was waged against the corn borer.

Under the provisions of the Federal appropriation, New York State as infested territory, came in for a share of this money and a comprehensive educational campaign was planned and carried out. It is the intention here briefly to outline as a matter of record, the organization and operation of this work in the State.

Previous to the special Federal appropriation, a very definite program for the control of the corn borer had been initiated by the Farm Bureau organization in New York State. Due to increasing commercial damage to corn in certain sections a conference was called at Syracuse in November 1926. There were present delegates from the Farm Bureaus in the more heavily infested counties, namely, Niagara, Erie, Chautauqua, Cattaraugus, and Orleans in the western part of the state, and from the Schenectady area and from Nassau Co., on Long Island in the eastern part. The State Entomologist, representatives of the State Department of Agriculture and Markets, together with those from the Departments of Entomology and Agronomy of the State College of Agriculture were also in attendance. The outline of a proposed comprehensive educational campaign, drawn up thru the efforts of Mr. L. R. Simons, Chairman of the State Corn Borer Educational Committee, was presented. With some changes this was approved. The campaign was then definitely started in four of the western New York counties mentioned above. The Schenectady area was also included. This was done at a conference in each county with the County Agent, the president of the County Farm Bureau, a representative of the Federal Corn Borer Laboratory at Silver Creek, N. Y., and a representative from the State College. A little later a second meeting was held in each county at which County Corn Borer Committees were organized. These committees consisted of one representative farmer from each of the more heavily infested communities. These assumed the responsibility of putting up posters, arranging for window displays, distributing educational leaflets, securing signed clean-up pledge cards, and of talking on control measures at corn borer meeting of granges, cooperative associations, etc.

The campaign as outlined and adopted at the Syracuse meeting was designed to make the fullest use possible of every existing organization and agency in the territory included, for the distribution of pertinent information concerning the corn borer and the best known and most practical methods for its control. The campaign included publicity thru the local press, Farm Bureau News, etc., radio talks, the use of lantern slides and motion pictures, and the widespread distribution of leaflets, folders, posters, window displays and the like. It was carried out largely thru the County Farm Bureaus and their local corn borer committees. A State Corn Borer Committee had been formed early in the campaign consisting of various interested departments at the State College. This committee had received excellent cooperation from the specialists of the State College of Agriculture, the State Department of Farms and Markets, the State Entomologist's office, the Geneva Experiment Station, the State Canners, and the State Thrasherman's Association. One of the recommendations made by the State Committee was the need for paid field specialists in each county to address meetings, to visit farmers, and in other ways to bring to the attention of growers the importance of the corn borer and to instruct them in the use of the best control measures.

After the Corn Borer bill was passed by Congress but before it had been endorsed by all the States, a meeting was held in Buffalo attended by representatives of all the official agencies, educational and regulatory, and by representatives of the Farm Bureau organizations in the infested counties in western New York. The situation was fully presented by Assistant Commissioner of Agriculture Norgord and the proposition of placing a restricted area under regulation was indorsed by the Farm Bureau representatives, altho they were not in a position to speak officially for the farmers in their territory. In order to make sure that the farmers in the proposed regulatory area fully understood the plans and to secure their endorsement and hearty cooperation in the undertaking, Mr. Norgord, held a series of public meetings in this area and in each case secured their enthusiastic approval of the proposition. This consumed considerable time and effort but later developments showed the wisdom of such a method of procedure. The farmers had a feeling that it was their campaign against the pest and they cooperated heartily thruout the season. This mutual understanding of the situation eliminated unnecessary friction in enforcing the regulations and avoided a very natural reaction on the part of the growers that something was being put over on them by outside government agencies. As a result of this friendly approach, the otherwise natural criticism of many operations was disarmed and the farmers had a tendency to look with indulgence on some of the mistakes naturally attendant on operations of such magnitude initiated upon such short notice. In this way a public opinion was developed which tended to enforce the regulations in the case of careless or indifferent growers without its being necessary to resort to legal action in any case. The result is that the great majority in this regulatory area have expressed themselves as favoring a continuation of some form of compulsory clean-up for another season. Not only that, but the general satisfaction of the farmers in the clean-up area has been so nearly universal that those in the adjacent territory are requesting an extension of the operations to include their communities during the coming season.

Because of previous experience with other compulsory campaigns some of the responsible leaders in the County Farm Bureau organizations had grave misgivings as to the wisdom of their organization being officially identified with the corn borer clean-up, but the experience of the past season has convinced them that their fears were unfounded because their organizations have been actually strengthened, due in part at least, to their aggressive stand on this question.

When word was received from the Federal Department of Agriculture that a special appropriation had been made for the control of the corn borer and that the money would shortly be available, plans were at once made to enlarge and intensify the campaign already under way. One of the most important additions was the appointment of several County Corn Borer Specialists who functioned as special assistant county agents.

One of the first steps after the appointment of the additional personnel to handle the campaign from then on, was the calling of a conference at Buffalo to thoroly discuss plans. Mr. L. R. Simons, who had recently been appointed assistant to Mr. G. D. Farrel, in charge of Corn Borer Educational Work in the infested States, presented the suggestions of the Federal Department of Agriculture for Corn Borer Work. Suggestions were also outlined for the special assistant county agents in each county as to organizations and agencies thru which to work, details of what had been done so far in the county, and as to the publicity, exhibit and general educational material available for use. In this work of course, all agencies and organizations such as schools, granges, rural churches, Rotary and Kiwanis Clubs and the like, which could help spread the necessary information, were utilized.

The regulatory work was under the direction of the State Department of Agriculture and Markets with the U. S. Bureau of Entomology cooperating closely. Commissioner of Agriculture B. A. Pyrke and Assistant Commissioner C. P. Norgord were in general charge for the State. Messrs. G. F. Wheaton and Harold Smith of the State Department of Agriculture and Markets were deputized by the Federal Government and placed in immediate charge of all regulatory work. Mr. H. N. Bartley, in charge of regulatory work in the eastern sector, and Mr. S. B. Scott in charge of the Federal Corn Borer Laboratory at Silver Creek, N. Y., were closely associated with them.

The regulatory area as finally decided upon comprised 32 townships in Erie, Chautauqua and Cattaraugus Counties. These constituted roughly nearly the whole southern half of Erie, the northwestern quarter of Cattaraugus, and the northwestern half of Chautauqua Counties and bordered the shore of Lake Erie from the outskirts of Buffalo west to the Pennsylvania line. About 8453 farms were located in this area on which were grown a total of approximately 40,000 acres of corn. Altho much of this was field corn several large canneries for sweet corn operated in the territory.

The growers in this regulatory area were given until May 1st to plow under all corn stubble and to burn or otherwise dispose of all corn stalks or corn refuse for which they were to receive not to exceed $2.00 per acre for any extra labor involved. Because of extremely unfavorable weather for clean-up operations this date was extended to May 15th and where necessary many growers were given until June 1 to complete the work. After that date the work was to be completed by Federal agents with government operated machines.

It was feared by some of those having the welfare of the Farm Bureaus at heart that unfair advantage would be taken by irresponsible agents to sell machinery either unnecessary or unsuited to local conditions, but the manufacturers are to be commended for their attitude in keeping the whole enterprise on an educational basis, thereby not only furthering their legitimate interests in the territory but also contributing to the general welfare of the farmers.

The publicity of the campaign was in charge of Professor Bristow Adams, head of the News Service of the State College of Agriculture. In accordance with the settled policy of his office care was exercised that all information sent out had real news value and contained only such information as was of value to the grower reading it. The quantity was strictly limited to the actual needs of the papers so as to avoid giving the editors the impression that they were being flooded with propaganda. Due to this general policy the press service of the College of Agriculture has won the confidence of the great majority of the editors in the State and in this emergency received their hearty cooperation. Local publicity in the clean-up area was handled by Miss Marjory Short of Westfield, N. Y., a graduate of the State College, having specialized in journalism, and with considerable experience as a practical newspaper woman. She was able to give the news a local setting.

A single sheet leaflet was prepared by Dr. P. J. Chapman of the State College of Agriculture giving in concise form·the life-history and most practical methods of controlling the corn borer. This was distributed extensively to the growers and several editions were printed. It answered their two most important and constantly recurring questions—what is this corn borer and what is the best way to fight it. By restricting ourselves almost entirely to this one publication much unnecessary confusion in the mind of the grower was avoided.

Situated in the center of the most heavily infested area in western New York was the Cattaraugus Indian Reservation embracing about 20,000 acres of land owned by the Seneca Indians and surrounded by some eight townships in three adjoining white counties. These Indians are not government or state red men but are on lands which they reserved for themselves. Corn being the chief crop of these original corn growers and since the corn borer laws passed by Congress and the State

Legislature had no application to them, the county agricultural agent of Erie County, and others responsible for the clean-up, found a difficult situation facing them. With the aid of Dr. Earl Bates, head of the Indian Extension Work of the State College of Agriculture, appearances were made before the Seneca Indian Council and after the councilors were brought out into infested fields and shown the damage, they went back into council again and passed the joint state and federal corn borer laws by translating them into their native Iriquoian and placing them among their ancient code of laws. This is the first time in the history of America that an agricultural regulatory act has been written into Indian law. The Cornell Indian Boards immediately got behind the movement and with the help of Messrs. Bartley and Stockbridge of the Federal Department and a Special Indian Corn Borer Agent, Mr. Russell Hill, this reservation is today the cleanest section in the regulatory area in all western New York.

On the three other Indian Reservations, not in the regulatory area, the Cornell Indian Boards obtained better than a 97% clean up by May 1st and the rest was clean by June 1st, that is, as soon as the waters receded on their bottom lands. The cooperation of the Indian farmers in fighting the pest was equal to their white neighbors and in many cases was better. It represents an epic in extension service among Indians.

SOME MACROSCOPIC EFFECTS RESULTING FROM THE FUMIGATION OF PLODIA LARVAE WITH CARBON DISULPHIDE IN RELATION TO REVIVAL POTENTIALITIES

By J. C. Hamlin, *Associate Entomologist, and* W. D. Reed, *Assistant Entomologist, Stored Product Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture*

Abstract

Grown larvae of the Indian-meal moth (*Plodia interpunctella* Hbn.) revived from one to two weeks after fumigation with carbon disulphide at the rate of 2 pounds per 1000 cubic feet, in the latter part of October at Fresno, Calif. During the period of inactivity between fumigation and revival, the potential revivals may be detected with considerable accuracy by their retention of a nearly normal color and a fair degree of turgidity, and by their not being severely shriveled. Among such individuals, however, one can not determine which or what percentage, will later become fully resuscitated. Congestion of the intestinal tract is a common condition of reviving larvae and is operative in causing the subsequent death of a portion of them. Five larvae, revived from the 6-hour exposure, developed to the adult condition.

INTRODUCTION

During the past two years hundreds of larvae of the Indian-meal moth fumigated with carbon disulphide under commercial conditions have been examined to determine their capabilities for revival. In this work the writers acquired the ability to detect with much accuracy by appearance those capable of recovery. The purpose of the study here reported was to correlate the external characteristics with revival by making detailed observations on a small number of larvae fumigated under known conditions.

EXPERIMENTAL CONDITIONS

After the evaporation of carbon disulphide applied at the rate of 2 pounds per 1000 cubic feet of space, in a 12-gallon bottle, four lots of larvae were suspended in the bottle. Lots 1, 2, and 3 in cheesecloth bags of single-thickness, were situated at the center. Lot 4, enclosed in a glass cylinder 1.5 inches in diameter by 2.5 inches long, having each end covered by a single thickness of cheesecloth, was suspended below the others at a point one-third the height of the bottle from the bottom. Each lot contained 10 well-grown Plodia larvae and was arranged for separate removal. After fumigation each lot was inspected and the larvae placed in individual vials for protracted examination. After their revival raisins were supplied as food.

REVIVAL

Revival was determined daily by the reaction of larvae when lightly touched with a blunt instrument at several points on the dorsum. The initial movement occurred in the head region and was usually very slight, often necessitating the use of the hand lens. As the head and its organs acquired greater capability of movement, this power gradually extended posteriorly, the posterior one-third of the larva always being last in the recovery of normal muscular activity.

The highest temperature during the experiment, 77° F., obtained during the first six hours and therefore applies to each of the four series. In series 1, 5 larvae exhibited slight movement immediately after removal from the fumigatorium. Thereafter none gave evidence of life until the eighth day, when 7 of the 10 revived. A total of 9 larvae revived, the latest recovery being 12 days after fumigation; 7 larvae remained alive 7 weeks after fumigation. In series 2 no individuals exhibited movement through the tenth day; a total of 7 larvae revived from the eleventh to the thirteenth day, and 4 larvae survived 7 weeks after treatment. Revival in series 3 was restricted to the period between the eleventh and the fourteenth day; a total of 5 larvae revived, and 1 of these survived 7 weeks after fumigation. In series 4 a single larva revived on the fifteenth day and succumbed two days later. The exposures of these series were approximately 6, 20, 25 and 30 hours respectively.

Physical Condition of Fumigated Larvae

During the first 7 days after fumigation, when all larvae appeared lifeless they were characterized by varying degrees of rotundity, shriveling, and limpness, as well as by differences of color. These features were gauged visually, except limpness, or turgidity which was determined in connection with the above-mentioned test of irritability.

Lessened turgidity was a constant effect of fumigation. It varied much, ranging from slight limpness to almost complete lack of turgidity, with the posterior one-third of the body less turgid than the anterior portion. This criterion alone indicates that the greater the lack of turgidity the less is the likelihood of revival and, if revival occurs, the greater is the probability of early death. Rotundity was usually associated with turgidity, the somewhat flattened condition ordinarily indicating great lack of turgidity. Sometimes, however, larvae almost entirely devoid of turgidity retained the normal rotundity and, conversely, now and then a considerably flattened larvae exhibited a fair degree of turgidity.

More or less shriveling of the larval surfaces followed fumigation. Slight wrinkling was common with the larvae which revived, while individuals exhibiting severe and rapid shriveling usually failed to revive. Between these extremes this character appeared to have little significance regarding revival.

Shortly after fumigation the color of all 40 larvae, except one, approximated the normal pale yellow color. Later, discolorations of different sorts appeared, the most common change being the assumption of a slightly darker yellow color. Sometimes the darkening continued until the larva finally became uniformly brownish to black, but usually the darker color attached only to portions of the body. The exceptional larva above noted was uniformly black on the first day after fumigation; thereafter it rapidly softened, although retaining its form for several days. Many larvae exhibited an indistinct whitish or pale pinkish hue beneath the dorsal covering of the posterior end of the body, but this condition apparently bore no definite relation to revival. It is noteworthy that all reviving larvae were of the normal color or a slightly darker yellow, but not all larvae so colored revived.

Visual examination alone enables the detection of death with certainty in the case of larvae marked by extreme shriveling or discoloration. By collective consideration of the characteristics which have been mentioned, the probability of revival of a larger proportion of the larvae may be gauged with reasonable accuracy. An estimate of the outcome under the conditions of this experiment would not, however, have been possible, except in unusual instances, until 4 or 5 days after fumigation. After revival, too, certain conditions serve to indicate those individuals which may be expected shortly to succumb.

CONGESTION OF THE INTESTINAL TRACT OF FUMIGATED LARVAE

The excretion of revived larvae was carefully followed. The initial discharge of feces always occurred several days after the first signs of life were displayed. The excrement of revived larvae was usually quite watery, instead of presenting the normal pellet form, although several individuals were found with elongated gummy portions of feces adhering to the anus. Two larvae, apparently fully recovered otherwise, were observed expanding and contracting the anal muscles in a vain attempt to defecate. Two other revived larvae, not of this experiment, were greatly inflated at the posterior end of the body prior to excretion. A small, dark, internal spot just before the anal pore was observed in the majority of revived larvae prior to excretion, and seemed to be associated with a disturbed condition of the intestines.

These observations strongly indicate that a congestion of the intestinal tract follows revival. The immediate causes contributing to such stoppage are remote. In revived individuals the digestive activities were undoubtedly operative, although at a very greatly retarded rate, during the period of suppressed irritability, thus allowing the slow movement of ingested food through the digestive tract during dormancy. Since the posterior portion of the larva is most severely incapacitated and is last to regain its normal muscular functions, it follows that the fecal material would accumulate in the intestines by virtue of the inactivity of the muscles necessary for its excretion. Completely normal locomotion was not observed to obtain prior to at least partial discharge of the fecal matter.

The cause of the watery or gummy consistency of feces excreted by revived larvae is conjectural. Although this may be due to some effect

ULTIMATE DISPOSITION OF REVIVED LARVAE LIVING SEVEN WEEKS AFTER FUMIGATION

Series No.	Vial No.	Date of Revival	Interval From Fumigation to Revival (Days)	Date Pupated	Interval From Revival to Pupation (Days)	Date Emerged	Sex of Adult	Interval From Revival to Emergence (Days)	Date of Death[a]	Interval From Revival to Death (Days)
1	1.1 (b)	Nov. 5, 1926	8	Nov. 27, 1926	30	Jan. 14, 1927	F	70	1927	—
1	1.2 (b)	Nov. 5, 1926	8	Feb. 22, 1927	117	Mar. 27, 1927	M	142	—	—
1	1.3	Nov. 5, 1926	8	Nov. 17, 1926	20	Dec. 30, 1926	F	55	—	—
1	1.7 (b)	Nov. 5, 1926	8	Feb. 23, 1927	118	—	—	—	Feb.	—
1	1.8 (b)	Nov. 5, 1926	8	Feb. 24, 1927	119	Apr. 1, 1927	M	147	—	—
1	1.9 (b)	Nov. 5, 1926	8	—	—	—	—	—	Feb. 7, 1927	94
1	1.10	Nov. 5, 1926	8	Nov. 26, 1926	29	Jan. 18, 1927	M	74	—	—
2	2.2	Nov. 9, 1926	11	Dec. 7, 1926	39	—	—	—	—	—
2	2.3	Nov. 11, 1926	13	—	—	—	—	—	Feb. 19. 1927	100
2	2.5	Nov. 11, 1926	13	—	—	—	—	—	Feb. 12, 1927	93
2	2.9	Nov. 9, 1926	11	Dec. 7, 1926	39	—	—	—	—	—
3	3.8	Nov. 9, 1926	11	—	—	—	—	—	Feb. 14, 1927	97

[a] For those which died after pupating the date of death can not be shown.

[b] Exhibited slight movement at initial examination.

of the fumigant upon the physiology of the larva, it seems more probable, in view of the sugar content of the ingested raisin pulp, that the altered nature of the feces may result from enzymatic or micro-organic fermentation. The inflation of larvae above mentioned appears to indicate gas pressure from fermentative action.

Deaths of revived larvae occurred at various times with reference to excretion; some died before any discharge of feces, and some after partial discharge; in some few cases the gummy excrement which remained attached to the anus dried and anchored the larva to the vial. The difficulty of excretion may fairly be said to result in the death of a fair proportion of revived larvae. If revived individuals are able to defecate they have excellent chances of complete recovery.

Subsequent Development of Revived Larvae

Table 1 shows the extent of subsequent development of the twelve larvae from series 1, 2, and 3 which survived 7 weeks after fumigation. Especial interest attaches to these results as showing the developmental potentialities of larvae reviving from fall fumigation, and which must then undergo an extended period marked by conditions unfavorable to further development until approach of the warmth of spring Taking the series in reverse order, it may be noted that the larva of series 3 succumbed late in the winter and before pupating. Of the 4 larvae in series 2, two pupated in early winter but failed to emerge; the other two died as larvae late in the winter. In series 1 one larva died late in winter, before pupating, one which pupated late in winter failed to emerge; and the remaining five pupated and issued as adults from December 30, 1926, to April 1, 1927. Two of the individuals which exhibited slight movement immediately after removal from the fumigatorium failed to reach the imaginal condition, whereas two which showed no evidence of life at the initial examination revived later and were among the five producing adults.

COMMON NAMES OF INSECTS APPROVED FOR GENERAL USE BY AMERICAN ECONOMIC ENTOMOLOGISTS

Third Supplement to list Appearing in Volumn 18, Pages 521-545

The following list of common names was prepared by the Committee on Nomenclature of the American Association of Economic Entomologists in conformity with instructions given by the Association at its last regular meeting. A list of 11 names was submitted to the members of the Association and of these names the following 6 have met with their approval:

INSECTS LISTED BY COMMON NAMES

Cotton flea hopper	Psallus seriatus Reut.
Hickory shuck worm	Laspeyresia caryana Fitch
Pecan nut case bearer	Acrobasis (hebescella Hulst.) caryae Grote.
Persimmon psylla	Trioza diospyri Ashmead.
Vegetable weevil	Listroderes obliquus Gyll.
Wheat stem sawfly	Cephus cinctus Nort.

INSECTS LISTED BY SCIENTIFIC NAMES

Acrobasis (hebescella Hulst.) caryae Grote	Pecan nut case bearer
Cephus cinctus Nort	Wheat stem sawfly.
Laspeyresia caryana Fitch	Hickory shuck worm
Listroderes obliquus Gyll	Vegetable weevil.
Psallus seriatus Reut	Cotton flea hopper.
Trioza diospyri Ashmead	Persimmon psylla.

Scientific Notes

Studies on Nectar in Relation to Honey Production. During the past three years, the writer has made extensive studies on the nectar of plants at the Apicultural Laboratory of the Iowa Agricultural Experiment Station. The purposes of these researches are: (1) To discover factors which influence either the quantity or the quality of the nectar produced by a given species or variety, (2) To find means for measuring the value of a given species or variety as a honey producer, and (3) To advance our knowledge of how the honeybee changes nectar into honey.

More than 900 samples of nectar from dozens of plant species and from numerous varieties of certain species, have been studied by means of both chemical and physical methods. Numerous samples were obtained from the more important honey plants of Iowa, and many were taken from minor and miscellaneous sources.

Only a few of the outstanding results of these studies can be mentioned here, but a detailed report will appear in a subsequent paper from the Iowa Agricultural Experiment Station. Some of the important findings follow:

1. As a rule, nectars which are secreted abundantly have a lower sugar concentration than do those which are secreted less abundantly.

2. The great majority of the samples studied contained between 40 and 55 per cent sugar. Comparatively few ran below 30 or above 60 per cent.

3. Nectar from a given source was found to vary over a considerable range in its sugar concentration. One of the most important of the causal factors was found to be the relative humidity of the atmosphere. By taking samples of nectar from a given species at frequent intervals thruout the day, it was found that the variations in sugar concentration formed a smooth curve which was practically the reverse of the relative humidity curve for the same day. Another factor which appears to

cause variation in nectar concentration is sunshine (or shade) but its effect seems to be comparatively slight.

4. In some species of plants, the same flower continues to secrete nectar thruout a period of several days.

O. W. Park

Carbon Dioxide a Chemical Accelerating the Penetration of Respiratory Insecticides Into the Tracheal System by Keeping Open the Tracheal Valves. When studying the regulation of respiration in insects, the writer found that carbon dioxide has a very marked influence not only on the ordinary respiratory movements but also (in lower concentrations) on the tracheal valves (E. H. Hazelhoff, "Regeling der ademhaling bij insecten en spinnen," diss. Utrecht 1926; "On a new form of breathing regulation (regulation of diffusion) in insects and Arachnida," Proceedings of the Koninklijke Akademie van Wetenschappen at Amsterdam, Vol. XXIX, 1926, p. 492; and H. Jordan, "Die Regulierung der Atmung bei Insekten und Spinnen," Zeitschrift für vergleichende Physiologie, Abt. C der Zeitschrift fur wissensch. Biologie, Vol. V, 1927, p. 179). *Periplaneta americana* e.g. displays no respiratory movements when at rest (at room temperature), and its *tracheal valves are nearly closed;* when the animal is brought into an atmosphere containing 2 or 3% carbon dioxide, *the spiracles open immediately*, thus allowing a more rapid diffusion of the respiratory gases. When the carbon dioxide pressure is raised to about 7 or 10% or more, ordinary respiratory movements of the abdomen appear.—The width of the spiracle opening turned out to be regulated normally by the amount of carbon dioxide diffusing out of the tracheal system, or rather by the carbon dioxide pressure in the immediate neighbourhood of the spiracles; so e.g., the tracheal valves were observed to open more and more widely when metabolism was gradually increased by a rise in temperature.—Since the same was found to apply to several other insect species of different orders, it seems probable that we are able to accelerate the penetration of respiratory insecticides (HCN, CS_2 etc.) into the tracheal system by the application of a small amount of carbon dioxide; in this way the insecticidal action of a definite concentration of a fumigant might be increased, or the same effect might be obtained by a lower concentration or by a shorter exposure to the same concentration. It therefore seems probable that the increased susceptibility to hydrocyanic acid in higher temperatures as observed by Brinley and Baker ("Some factors affecting the toxicity of hydrocyanic acid for insects," Biol. Bull. LIII, 1927, p. 201) is to be explained by the influence of increased metabolism (and therefore of increased output of carbon dioxide) on the width of the spiracle opening.—Further investigations on the practical aspects of this question seem highly desirable.

Dr. E. H. Hazelhoff, *Sugar Cane Experiment Station, Pasoeroean (Java).*

Experiments on Control of *Eutettix tenellus* (Baker). After many months of experiments with emulsions, the writer has secured the following excellent results:

1. Emulsion of 75 per cent Oronite Fly Spray (Standard Oil of California), and 25 per cent whale oil soap and water.
    a. Diluted with 19 parts of water, a kill of 100 per cent was obtained in one and one-half hours in a cage exposed under field conditions. Temperature of 110 degrees Fahrenheit at ground near foliage with thermometer facing away from sun.
    b. Diluted with 39 parts water, a kill of 94 per cent was obtained in one and one-half hours under conditions as in (a).

2. Emulsion as in (1) using 70 per cent Fly Spray and 30 per cent whale oil soap and water.

a. Diluted with 19 parts of water, a kill of 100 per cent was obtained in one hour in a cage as in (1a) under conditions similar to (1a).

3. Emulsion as in (1) using 60 per cent Fly Spray and 40 per cent whale oil soap and water.

a. Diluted with 19 parts of water, a kill of 100 per cent was obtained in one hour in a cage as in (1a) under conditions similar to (1a).

4. Emulsion as in (1) using 50 per cent Fly Spray and 50 per cent whale oil soap and water.

a. Diluted with 9 parts of water, a kill of 100 per cent was obtained in one hour in a cage as in (1a) under conditions similar to (1a).

b. Diluted with 19 parts of water, a kill of 100 per cent was obtained in two hours in a cage as in (1a) under conditions similar to (1a).

c. Diluted with 39 parts of water, a kill of 90 per cent was obtained in 5 hours in a cage as in (1a) under conditions similar to (1a).

5. Emulsion as in (1) using 25 per cent Fly Spray, and 75 per cent whale oil soap and water.

a. Diluted with 19 parts of water, a kill of 100 per cent was obtained in one hour in a cage as in (1a) under conditions similar to (1a).

b. Diluted with 29 parts of water, a kill of 100 per cent was obtained in two hours in a cage as in (1a) under conditions similar to (1a).

c. Diluted with 39 parts of water, a kill of 92 per cent was obtained in five hours in a cage as in (1a) under conditions similar to (1a).

6. Check—50 bugs placed in a cage, untreated, were all alive at the end of 5 hours.

7. Plain water sprayed on a cage of bugs under conditions as in (1a) produced a kill of 94 per cent in two hours. This may be an explanation of the effect of rain in the intermountain country in late spring or early summer. Apparently, the high humidity near the ground with a high temperature are fatal to the insect.

8. A spray like 5a was tried with a temperature of 94 degrees Fahrenheit. Under cage conditions, a kill of 97 per cent was obtained in the field.

The writer has come to the conclusion that we now have an economical spray for beet field spraying.

Nine years of continual foothill observations have convinced the writer that it is possible to sufficiently reduce the foothill bugs on the west side of the San Joaquin Valley by trapping on preirrigated sugar beet patches, say five acres each and a mile apart, and killing these bugs over a period of four or five weeks to be of economic value. The patches of beets would be planted as near the low foothills as possible. In most years, as the beet leaf hoppers move toward the foothills in the fall months, there is a decided scarcity of favorable green vegetation on the plains area, and a large number of hoppers could be trapped. Heavy, early September or October rains would nullify such a program. Such rains occurred but once since 1918, however. A reduction of fall numbers of 50 per cent might change the prospects of a bad blight year to a moderate blight year and would cut the necessary spray program in the beet fields.

E. A. SCHWING, *Entomologist, Spreckels Sugar Company, Sacramento, Calif.*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

OCTOBER, 1928

The editors will thankfully receive news matter and other items likely to be of interest to our readers Papers will be published as far as possible in the order of reception. Papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page. There is a charge of $2.50 per page for matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

Separates or reprints, if ordered, when the manuscript is forwarded, will be supplied to authors at the rates given below. Note that the number of pages in a reprint may be affected somewhat by the make-up, and that part of a page is charged as a full page. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

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The International Congress of Entomology fully met expectations and exceeded them in many respects. Men of international reputation from widely separated part of the world jostled elbows. The meeting place, the arrangements and their execution were representative of the best in scientific circles. The attendance of two octogenarians added much to the dignity and significance of the gathering with its representation of 38 foreign nations (there were 134 from foreign countries) and nearly 500 from all sections of this country—amateur, professional, systematic and economic workers all being well represented. It was truly international in aspect, and catholic in scope. There were discussions and papers on most of the many phases of Entomology and one could not but be impressed by the essential unity of all in the search for truth. To many Americans, this Congress meant the opportunity of a lifetime. It was an inspiration to all. May the next be equally successful. The meetings of the numerous sections not only focused attention upon the progress or need of progress in the various lines of investigation, but also aided materially in developing the international point of view. It is the writer's opinion that subsequent Congresses in Europe will be more generally attended by representatives from the Western Hemisphere. American Entomologists are certainly indebted to our foreign associates for the time and trouble they took to attend the Congress, and we are also under obligations to that enthusiastic group in this country which so successfully planned and carried out the details in relation to the numerous meetings and excursions. It is the consensus of opinion that much of the success of the gathering was due to the active interest and especial qualifications of the late Chief of the Federal Bureau of Entomology. It is certain that his wide personal acquaintance and charming manner were utilized to great advantage in his duties as presiding officer.

Book Reviews

Common Garden Pest: What They Are and How to Control Them.

by C. T. GREGORY, Pathologist, and J. J. DAVIS, Entomologist, of Purdue University Agricultural Experiment Station, Lafayette, Indiana. Published by *Better Homes and Gardens*, DesMoines, Iowa, 50 cents, postpaid.

This little book of 150 pages was evidently published by the magazine in order to supply information to subscribers at small cost. It contains six chapters as follows: Recognizing Plant Pests; Enemies of Garden Flowers; Lawns; Ornamental Trees and Shrubs; Vegetables; Appendix (Formulas, etc.).

The first chapter of 17 pages is devoted to a brief discussion of the nature of bacteria, fungi and insects, their injury to plants, and the natural and artificial means of control. An explanation is given of how insects feed, live and grow, and pass the winter. The second chapter of 63 pages treats of the chief pests of garden flowers and only the briefest description of each is given with directions for treatment. Only two pages are devoted to lawns in Chapter three. In Chapter four about 27 pages are devoted to the pests of ornamental shrubs and trees, and Chapter five contains about 31 pages on the pests of vegetables. In each of these four chapters the plants are arranged alphabetically by their common names. Chapter six contains 10 pages of information about insecticides, fungicides and soil treatment.

This book is attractively printed on smooth paper and illustrated with about 130 text figures, mostly half-tones, and bound in flexible paper covers. It is certain to prove most helpful to the amateur grower of plants.

W. E. B.

Sugar Cane Insects Around the World.

By T. E. HOLLOWAY, Published by Honolulu Iron Works, Honolulu, T. H. 1928.

This very interesting collection of five previously published popular papers on Sugar Cane Entomology has been assembled by the Honolulu Iron Works and published in booklet form. The following very significant statement occurs in the preface: "The literature of Entomology does not enjoy the popularity accorded to the literature of war, yet the literature of entomology is the literature of a war in which defeat means extermination—a war of defense against the armies of the insect world."

The first paper, Sugar Cane Insects Around the World, is a brief survey of entomological activities in most of the sugar cane countries, with mention of the principal workers and their main lines of activity.

In the paper on Methods of Controlling Sugar Cane Insects such control is considered under the four heads of Control by Chemicals, Bringing in of Foreign Parasites, Protection of Native Parasites, and Other Methods.

The third paper on Plant Quarantines to Protect the Sugar Industries is a very brief discussion of quarantine regulations against sugar cane insects.

The fourth paper is on Economic Entomology in the Sugar Industry and can be epitomized by one sentence in the first paragraph, as follows: "As chemistry has taken its place in the factory, economic entomology is coming to its own in the field."

The fifth and last paper is on the subject of Plantation Entomology, cites as an example of the work of this type of entomology the activities of the plantation entomologist employed by the United Sugar Companies of Los Mochis in the State of Sinaloa, Mexico.

Little volumes of this sort, particularly as in this case, sent out by companies with a commercial stake in the industry the world over, can be productive of much valuable popularization of an unfortunately little understood, but patently extremely important phase of plantation economics in sugar countries everywhere.

ARTHUR H. ROSENFELD, *Consulting Technologist, American Sugar Cane League.*

Schädlingsbekämpfung: by Dr. WALTHER TRAPPMANN. 440 pages, 68 figures. S. Hirzel, Leipzig, 1927.

This work is volume eight of the "Chemie und Technik der Gegenwart," edited by Dr. Walther Roth. It is really a handbook of the methods used in protecting useful and cultivated plants against injury by organic and inorganic factors. The material is presented from the viewpoint of the means of protection available. There are three main parts. The first part discusses the importance and aim of plant protection, giving a conception of the damage done to useful plants and the losses caused thereby as well as outlining certain definite factors which must be considered if plants are to be protected. The second part gives a general consideration of diseases and injuries. The author defines and enumerates the injurious factors, and discusses their injury to plants. This includes such inorganic factors as the poisonous atmosphere near industrial centers, unfavorable physical and chemical conditions of the soil, lack or surplus of water, unsuitable temperature and light, and climatic disturbances, as well as animal and vegetable parasites and predators. The relations between the parasites and the plant host are clearly brought out. The last two chapters of this part are given over to a discussion of symptoms of disease and to the appearance and spread of injurious organisms. In the third part are given methods of control and the pests which can be controlled by these methods. Under cultural methods are considered selection of site, care of soil, culture of plants, selection and breeding. Under biological control is discussed the balance of nature, bacterial control of rodents and locusts, fungous control of insects, parasitic insects, birds, etc. Much is said regarding control by physical means which are classified as mechanical (crushing, barriers of all sorts, frightening of birds, collecting and destroying, attracting, and changing the physical environment), heat and cold, light, and electricity. The chemical means of control include sprays, dusts, dry material strewn or spread, materials applied with a brush or similar means, materials poured or "watered" on, dips, steeping materials used against fungi, gases, vapors, baits, repellents, and inoculating materials. Each substance used or method employed is treated with regard to its chemical or physical nature, preparation, means of employment, apparatus involved, effect on pests and on host plants, practicability, origin, pests so controlled, and general use. The last two chapters discuss the value of control measures and the organization of control. The author calls attention to the fact that cultural methods are of primary importance, for prevention is better than cure, and that cultural methods and technical (physical and chemical) methods supplement each other, whereas technical methods may seriously undermine biological control.

No bibliography is appended, but the most important references are given thruout the text.

This is a carefully written and clearly elucidated book of much value and merit. There are few omissions worth mentioning, and the material is given in as much detail as space permits.

R. B. FRIEND, *Connecticut Agri. Exp. Sta., New Haven, Conn.*

Current Notes

Mr. George P. Engelhardt of Brooklyn Museum, Brooklyn, N. Y., recently visited the Victoria, B. C., laboratory of the Entomological Branch.

The Entomological Society of America has just received a bequest of $1,000 from the estate of the late Miss Mary E. Soule, of Brookline, Mass.

Science is authority for the statement that Mr. R. W. Tucker has recently been appointed Entomologist to Barbados, by the British Secretary of State for the Colonies.

Mr. M. C. Lane, Toppenish, Wash., visited Bozeman, Mont., July 18, to confer with Dr. J. R. Parker and others, of the Montana Agricultural Experiment Station, regarding the control of wireworms.

According to *Science*, Dr. James Davidson, chief assistant entomologist of the Rothamsted Experiment Station, England, has been appointed head of the department of Entomology at the Waite Agricultural Research Institute, University of Adelaide.

According to *Science*, Professor and Mrs. T. D. A. Cockerell have returned to the University of Colorado after a journey around the world. They recently visited New Caledonia, Fiji, Samoa, and the Hawaiian Islands.

Mr. C. R. Twinn, Entomological Branch, sailed on the S. S. Megantic from Montreal, on Aug. 23, for England where he will spend several weeks vacation, returning to Ottawa at the end of September.

Mr. E. E. Atwood, a graduate of the Connecticut Agricultural College, has been appointed Junior Entomologist in the Bureau of Entomology, and reported for duty at the Gipsy Moth Parasite Laboratory on July 19.

Dr. W. A. Riley, of the University of Minnesota, Dr. Vasco M. Tanner of Brigham Young University, Provo, Utah, and Dr. Alvah Peterson of Moorestown, N. J., visited the U. S. National Museum during July.

Mr. F. E. B. Pope, curator of Zoology in the Milwaukee Public Museum, during July, visited several points of entomological interest in the Eastern states, gathering insect material to be used in preparing exhibits for the Museum.

Dr. C. H. Richardson, Entomologist in the U. S. Bureau of Entomology, has been appointed associate professor of Entomology at Iowa Agricultural College and assistant chief of the department of Entomology in the Agricultural Experiment Station.

Mr. G. W. Berrier, temporary field assistant in the field laboratory of the Bureau of Entomology at El Paso, Tex., has been detailed to Tlahualilo, State of Durango, Mexico, to carry on flight studies of the pink boll worm.

Mr. H. L. Seamans accompanied Dr. J. McDunnough of the Division of Systematic Entomology, Entomological Branch, on a collecting trip to Yellowstone Park, July 16 to 31, and while at Bozeman, Mont., conferred with Dr. Cook on cutworm investigations.

Mr. J. E. Graef has been appointed Assistant Chief of the Bureau of Entomology. He will continue in charge of the Division of truck crop insects and will also be responsible for matters pertaining to the business administration of the Bureau.

Dr. Alvah Peterson of the Bureau of Entomology, who has been stationed at Riverton, N. J., engaged in research work on the Oriental fruit moth, resigned recently to accept a professorship in the entomological department of Ohio State University, Columbus, Ohio.

The New York Entomological Society, on August 10, held a reception at the American Museum of Natural History, to the foreign entomologists in the United States to attend the Fourth International Congress of Entomology at Cornell University, Ithaca, N. Y., August 12–18.

Mr. R. W. Burgess has been appointed Agent of the Bureau of Entomology to be located at San José, Calif., and, in cooperation with the California Experiment Station and the California State Department of Agriculture, to work on the problem of the vegetable weevil.

Mr. J. P. Spittall, Assistant Entomologist at the Annapolis Laboratory, died July 9, after a serious illness of several weeks duration. Mr. Spittall was a valued officer of the Branch and was closely connected with Mr. Kelsall in the general work of the laboratory.

In addition to continuing his services as Chief of the Bureau of Entomology, Dr. C. L. Marlatt has been designated Chief of the plant quarantine and control administration which was established July 1. Mr. S. A. Rohwer has been designated Assistant Chief of this administration.

Mr. S. E. Crumb, formerly connected with the tobacco-insects field laboratory of the Bureau of Entomology at Clarksville, Tenn., has been transferred to Puyallup, Wash., where he has established a new laboratory for the investigation of problems relating to the earwig on the Pacific Coast.

Mr. S. P. Harrell has been given a temporary appointment as Field Assistant at the bean beetle laboratory of the Bureau of Entomology at Estancia, N. M., to succeed W. J. Douglass, who has been probationally appointed Junior Plant Quarantine Inspector by the Plant Quarantine and Control Administration.

Dr. J. G. Needham, professor of Entomology at Cornell University, has returned from spending a year in China with the China Foundation for the Promotion of Education and Culture. He lectured before various Chinese Universities, gathered large collections of dragonflies and is preparing a monograph of the Chinese Odonata.

During the recent International Congress of Entomology, honorary membership was conferred by acclamation upon Dr. W. J. Holland, Director of the Carnegie Museum, Pittsburgh, Pa., and Dr. S. A. Forbes, Chief of the Illinois Natural History Survey. The only other American so honored is Professor J. H. Comstock, of Cornell University.

Messrs. B. R. Coad, in charge of the field laboratory of the Bureau of Entomology, at Tallulah, La., and R. L. Mitchell, airplane pilot, left Tallulah July 2 for Northville, Mich., to supervise the completion and installation of special equipment in the monoplane purchased for use in flight studies of the pink boll worm.

Messrs. E. J. Newcomer and M. A. Yothers, of the Yakima, Wash., field laboratory of the Bureau of Entomology, attended the eleventh annual meeting of the Northwest Association of Horticulturists, Entomologists, and Plant Pathologists, which was held at Vancouver and Victoria, B. C., June 25, 1928. Mr. Newcomer was president of the organization.

According to *Science*, Mr. William Cutright, Specialist on insects, of the U. S. Department of Agriculture, arrived in Yokohama, on June 28 for a year's stay in Japan and other Asiatic countries. He will carry on research work in Kyoto Imperial University on the Japanese flies parasitic on the American corn borer, the pearl moth.

Dr. Herbert Osborn, research professor at the Ohio State University, by vote of the Entomological Society of America, has been elected to honorary fellowship in the Society. Other honorary fellows are C. J. S. Bethune, J. H. Comstock, S. A. Forbes, L. O. Howard and E. A. Schwarz.

The Popenoe Entomological Club of the Kansas State Agricultural College held a field meeting at the insect fossil beds near Elmo, Kansas, on August 27th. The following entomologists were present: R. J. Tillyard, Camberra, Australia; F. Muir, Honolulu, Hawaii; W. Knaus, McPherson, Kansas; and G. A. Dean, R. L. Parker, J. W. McColloch, Gilbert Schenk, R. H. Painter, and H. R. Bryson, Manhattan, Kansas.

Dr. C. E. Mickel, Assistant Professor of Entomology and curator of the insect collection in the University of Minnesota, arrived in Washington July 1, under an appointment with the Bureau of Entomology, and will spend about two and one-half months arranging the Museum collection of Mutillids. Dr. Mickel has recently published revisions of some of the North American genera of Mutillidae, and has others in progress.

The following entomologists were visitors at the laboratories of the Department of Entomology, Kansas State Agricultural College during July and August: J. S. Houser and G. A. Filinger, Wooster, Ohio; E. A. Back, Washington, D. C.; H. H. Schwartz, Bentonville, Ark.; W. B. Gurney, Sydney, Australia; R. J. Tillyard, Canberra, Australia; F. Muir, Honolulu, Hawaii; V. M. Tanner, Provo, Utah; and Paul M. Gilmer, Wichita, Kansas.

Prof. K. L. Henriksen, Assistant Curator of the Zoological Museum of Copenhagen, Denmark, arrived in Washington on July 24 and remained until August 9 when he left for the International Entomological Congress in Ithaca, N. Y. Although Dr. Henriksen has made a special study of trilobites and coleopterous larvae he is also interested in a general way in the entomological collection of the U. S. National Museum.

F. W. Boyd, of the Bureau of Entomology, has been transferred, effective July 23, 1928, from the field laboratory at San Antonio, Tex., to the field laboratory at New Orleans, and will be in charge of the sub-laboratory at Beaumont, Tex. With this as a center, studies will be made in eastern Texas on the sugar-cane moth borer as a pest of corn. The work will be conducted in co-operation with the Texas Agricultural Experiment Station.

Dr. H. E. Ewing, assisted by C. S. East, a taxidermist of the U. S. National Museum, spent most of July in eastern Virginia and North Carolina, getting records of vertebrate hosts for chiggers and other ectoparasites. It is of interest to note that no chiggers were recorded on small mammals, but many on ground-frequenting birds—all new host records for chiggers. Messrs. Ewing and East also took an unusual oestrid larva from the white-footed mouse.

The first shipment of parasite material received from Europe this year came from Poland and reached the Gipsy Moth Laboratory on May 18. Other shipments have since been received from Poland, Jugoslavia, Hungary, and Austria. The material has consisted of tachinid puparia and Hymenopterous cocoons of the genus Hyposoter. Biological studies are being carried on at the laboratory with some of the tachinids received, especially in an attempt to find out what native insects may serve as overwintering hosts.

Messrs. E. R. Buckell, E. P. Venables and A. A. Dennys of the Vernon B. C., laboratory, attended the meetings of the Northwest Association of Horticulturists, Entomologists and Plant Pathologists, held at Vancouver and Victoria, June 25 to 28. Messrs. R. Glendenning and W. Downes also were present at the meetings. Mr. Buckell states that reports of grasshopper abundance and injury to crops have been received from the dry range lands adjoining the Fraser river from Big Bar to the Chilcotins.

In July several Junior Entomologists were appointed and assigned, as here specified, to duty in the Division of Cereal and Forage Crop Insects, Bureau of Entomology. Morris Schlosberg has been assigned to duty at Toledo, Ohio, August I. Balzer, Ferdinand F. Dicke, and Luther G. Jones at Monroe, Mich., Clarence C. Crooks and Thomas V. Henneberry at Sandusky, Ohio, William A. Douglas at New Orleans, La., Eugene D. Eaton at Carlisle, Pa., Ford H. Harries at Salt Lake City, Utah, Hosea S. Hollingsworth at Wichita, Kans., and D. D. Questel at Arlington, Mass.

Dr. R. J. Tillyard, Commonwealth Entomologist of Australia, and Mr. J. W. Evans, who is one of his assistants, visited the Kansas State Agricultural College, May 19 to 22. On May 20, a special field meeting of the Kansas Entomological Society occurred at the fossil beds at Elmo, Kansas. A number of excellent fossil insects were taken, most of which were identified in the field by Doctor Tillyard. On Monday, May 21, Doctor Tillyard addressed the Zoological and Entomological Seminar on the subject of "The Relation of the Study of Fossil Insects upon Insect Evolution."

Dr. J. M. Swaine, Entomological Branch, left Ottawa for Australia, on July 19. He will represent the Branch at the Imperial Forestry Conference which is being held in September and October. Four other Canadian delegates from the federal and provincial Forest Services are also attending the conference. One month will be spent in Australia and Tasmania, during which the members of the conference will travel through forested sections commencing at Perth in western Australia and passing through the south to the east coast, finally visiting the sub-tropical forests north of Brisbane. The last two weeks of the conference will be held in New Zealand. Dr. Swaine expects to return to Ottawa in November.

The Western Plant Quarantine Board recently passed the following resolution: That the Western Plant Quarantine Board, at its 10th Annual Conference in Salem, Oregon, July 12–14, 1928, does heartily approve the movement looking toward more extensive study of foreign pests and diseases in the countries where they are now prevalent; and directs the transmission of a copy of this resolution, as an indication of its support, to the committees recently appointed by the American Phytopathological Society and the American Association of Economic Entomologists to promote jointly such important work.

Horticultural Inspection Notes.

Mr. W. B. Wood, District of Columbia Inspection Service, spent parts of the months of August and September in Michigan on narcissus bulb inspections.

Mr. Bousson Davison, who has assisted as Junior Plant Quarantine Inspector at New York City since October 1, 1927, resigned on August 15, 1928.

Mr. Daniel E. Gower, a graduate of the Michigan Agricultural College, was appointed a Junior Plant Quarantine Inspector on August 1, 1928, to assist at the port of Detroit, Mich.

Mr. Reginald C. Watson, who graduated from the New Mexico A. & M. College, was appointed a Junior Plant Quarantine Inspector on July 16, 1928, and assigned to the port of Nogales, Ariz.

Mr. Warren R. Sudduth, who was formerly employed in the Federal Pink Bollworm Eradication work, was reinstated in the Mexican Border Inspection Service on July 31, 1928, and assigned to the port of El Paso, Tex.

Mr. W. H. Baskin who had been employed as Junior Plant Quarantine Inspector at the port of Nogales, Arizona, since July 25, 1927, was transferred on July 18, 1928, to New Orleans, La.

Mr. E. R. Sasscer, In Charge Foreign Plant Quarantines, U. S. Department of Agriculture, visited New Orleans, La., Mobile, Ala., and several of the Florida ports from July 6 to 18 investigating banana shipments.

Mr. L. M. Scott, of the Washington office of the Plant Quarantine and Control Administration, spent the months of July and August inspecting special permit material at several points in the Middle West.

Mr. C. George Anderson, who received the degree of B. S. in Plant Pathology from the University of Minnesota, was appointed a junior Plant Quarantine Inspector on August 6, 1928, with assignment at the port of New York, N. Y.

Mr. C. R. Stillinger, Associate Pathologist in charge of the administration of the federal white pine blister rust quarantine in the Pacific northwest, has moved from 618 Realty Bldg., Spokane, Wash., to 406 Federal Bldg., in the same city.

Dr. J. H. Montgomery, State Plant Board, Gainesville, Fla., was in Washington several days during the latter part of August conferring with the Plant Quarantine and Control Administration regarding fumigation methods and requirements.

Due to the serious illness of Mr. M. C. Rich, Federal Inspector in Charge at San Ysidro, Calif., the work at that port was taken over on September 1, 1928, by Mr.

A. C. Hill, who has represented the Plant Quarantine and Control Administration at St. Louis, Mo., since 1925. With the transfer of Mr. Hill to San Ysidro, the port of St. Louis is closed in so far as the Administration is concerned.

Mr. John C. Prichett, a graduate of the Alabama Polytechnic Institute, was appointed a Junior Plant Quarantine Inspector on July 16, 1928, and assigned to the port of Nogales, Ariz., to fill the vacancy caused by Mr. Baskin's transfer.

Recent official announcements by the Plant Quarantine and Control Administration have included the following two circulars: PQCA-217 "Calcium Cyanide Fumigation for Bulb-Fly Control Authorized," and PQCA-218 "Restrictions Re Orchid Permits."

Mr. Geo. W. R. Davidson, a former employee of the United States Bureau of Plant Industry, was appointed August 14 to assist Mr. R. L. Clement, Nursery Inspector of the New York State Department of Agriculture and Markets, in the inspection of narcissus bulbs on Long Island.

Mr. B. D. Van Buren, Director of the Bureau of Plant Industry, New York State Department of Agriculture, spent August 22 and 23 in Washington, conferring with the Plant Quarantine and Control Administration regarding various regulations affecting the State of New York.

Appointments as Junior Plant Quarantine Inspectors pending certification have been made at New York City as follows: Mr. Norwood A. Eaton, Jr., a graduate of the University of Maryland, was appointed on July 14, 1928, and Mr. Paul X. Peltier, who was temporarily employed at New York City last year, on July 20, 1928.

The Federal European corn borer quarantine was amended, effective August 7, 1928, to add several towns and cities in Hudson County, N. J., to the regulated area and to require certificates and permits for the movement of corn and other restricted articles into the State of Maine from other parts of the regulated area.

Mr. Richard Faxon resigned as Chief of the Division of Plant Industry, Ohio State Department of Agriculture, on August 17, 1928, to accept a position with the Plant Quarantine and Control Administration in foreign plant quarantine work and is now stationed at 45 Broadway, New York City. His successor at Columbus has not yet been selected.

A public hearing was held by the Plant Quarantine and Control Administration on September 24 to consider the advisability of revising the Japanese beetle quarantine to include the States of Maryland and Virginia within the quarantined area, and of making its provisions applicable to infestations of certain other Asiatic beetles, namely, *Anomala orientalis*, *Aserica castanea* and *Serica similis*.

Dr. J. F. Martin of the Office of Blister Rust Control spent several days during the latter part of June in Wisconsin with Mr. E. L. Chambers and H. J. Ninman, making an inspection tour of the northern part of Wisconsin and familiarizing himself with methods of control and with respect to the white pine blister rust.

Mr. Leonard S. McLaine, Chief, Division of Foreign Pests Suppression, Ottawa, Canada, took advantage of his trip to the International Entomological Congress in Ithaca on August 12 to 18 to confer with Dr. C. L. Marlatt and other members of the Plant Quarantine and Control Administration staff regarding quarantine regulations which affect the shipments of plant material between the United States and the Dominion of Canada.

The Commissioner of Agriculture of Texas, on August 20, issued a revision of the regulations governing the growing and marketing of cotton in areas in Texas created regulated zones on account of the pink bollworm. Modifications included therein are largely those necessitated by the discovery of the pink bollworm in the western extension of the main cotton belt in the west-central part of the State.

Mr. W. A. Duffy, Commissioner of Agriculture of Wisconsin, and Mr. E. L. Chambers, State Entomologist, made a tour of Ohio, Pennsylvania and New York during June in a study of the European corn borer and white pine blister rust problems in those States. Many of the heavily infested blister rust areas in New York were visited and a study was made of the European corn borer control operation as carried out, especially in Ohio and Pennsylvania.

The Federal quarantine on account of the gipsy moth and brown-tail moth has been revised, effective August 1, 1928. The revision consists in the enlargement of the area designated as "generally infested" to cover a number of towns in Vermont, Massachusetts and Connecticut heretofore included in the lightly-infested areas, and in a modification which authorizes under inspection and certification the shipment from the generally-infested area of Christmas trees and greens originating in the lightly-infested area.

On July 24, the Harlingen, Tex., office of the Plant Quarantine and Control Administration issued a "Citrus Census of the Lower Rio Grande Valley of Texas as of July 1, 1928." The figures shown were gathered by inspectors enforcing the provisions of the Mexican fruit worm quarantine and are expected to prove useful as a basis for estimates of future administrative needs in connection with this project. The synopsis shows a total of 3,419,157 citrus trees growing in the regulated area, of which 477,202 have reached the bearing age.

Mr. F. S. Puckett, Administrative Officer of the Pink Bollworm Service, U. S. Department of Agriculture at San Antonio, was transferred on July 1, 1928, to Toledo, Ohio, where he became Administrative Officer of the European corn borer control project. Mr. S. D. Smith was promoted from his position in charge of the El Paso, Tex., district of the pink bollworm regulatory work to fill the vacancy thus created; Mr. J. S. Brock was transferred from Roswell, N. Mex., to El Paso, Tex., to take Mr. Smith's place; Mr. H. B. Prickett was transferred from Pecos, Tex., to the Roswell, N. Mex., area; and Mr. L. D. Harris was promoted to take charge of the regulatory work in the Pecos area.

Mr. E. A. Hodson, formerly of the Agricultural Extension Service of the State of Arkansas, was appointed in July to take charge of public relations and similar extension work in the Federal pink bollworm field service with headquarters at San Antonio, Tex. For several years, Mr. Hodson has been connected with the Agricultural Development Department of the Missouri Pacific Railroad Company, and is thoroughly familiar with extension methods. His work will be carried on in cooperation with the extension directors of the States of Texas, New Mexico and Arizona, and with the Cooperative Extension Service of the United States Department of Agriculture. It is anticipated that a part of each year will be spent in similar work in connection with the Mexican fruit worm eradication project.

The Plant Quarantine and Control Administration, U. S. Department of Agriculture, Washington, D. C., which succeeded the Federal Horticultural Board on July 1, has moved from the Entomology Bldg., on the Mall, and has taken over a five-story building at 1729 New York Ave., N. W. The Administration, under the direction of Dr. C. L. Marlatt as Chief and Mr. S. A. Rohwer as Assistant Chief, has been organized into eight administrative units as follows: Foreign Plant Quarantines—E. R. Sasscer in Charge; Domestic Plant Quarantines—S. B. Fracker in Charge; European Corn Borer—L. H. Worthley in Charge; Pink Bollworm and Thurberia Weevil—G. G. Becker in Charge; Moths—A. F. Burgess in Charge; Japanese Beetle—C. H. Hadley in Charge; Mexican Fruit Worm—P. A. Hoidale in Charge, and Date Scale—B. L. Boyden in Charge. Mr. B. Connor has been appointed as Business Manager.

The Federal white pine blister rust quarantine was revised, effective August 15, to include substantially the following changes of interest to shippers: Provision was made for the interstate movement, under permit, of five-leafed pines from the generally-infected areas consisting of the New England States, New York, and Washington, into the more lightly infected States east of the Mississippi Valley quarantine line, and also from Washington into Oregon and Idaho, when they have been raised from seed in a nursery free from currant and gooseberry plants and with a Ribes-free zone around the premises; the prohibition of movement from Wisconsin and Minnesota to Michigan, Pennsylvania, and New Jersey was removed; and the interstate shipment of cultivated red and white and mountain currant and cultivated gooseberry plants from infected States without a Federal permit and without environs inspection, was authorized, provided they have been dipped in lime-sulphur solution of specified strength, maintain the required conditions as to dormancy and defoliation, and are shipped within the prescribed period. Slight modifications were made in the shipping dates for currant and gooseberry plants as related to dormancy and defoliation with the expectation that these would correlate more closely with commercial nursery needs without any increase in the danger of dissemination of the rust to new localities.

Apicultural Notes

The Interstate Beekeepers' meeting was held July 25–26 at Dubuque, Iowa. This includes the states of Wisconsin, Illinois, Iowa, and Minnesota.

Dr. Martin Schwartz, Reichministerium für Ernahrung und Landwirtschaft, Berlin-Dahlem, Germany, visited the Bee Culture Laboratory, of the Bureau of Entomology, on August 11.

North Dakota beekeepers are fortunate in securing an appropriation of $2,000 for bee inspection. This is added to the original appropriation. Three deputies have been employed under the direction of the State Bee Inspector.

Miss Winifred S. Hull, temporarily employed as Field Assistant, at the Bee Culture Laboratory, of the Bureau of Entomology, resigned on August 25th in order to resume her studies at the Medical School of the Johns Hopkins University.

On June 27th the North Dakota Beekeepers' Association held a very successful meeting at Elizabeth, North Dakota. The meeting was well attended and there was an excellent program. The beekeepers were guests of the Elizabeth Kiwanis Club.

Dr. L. M. Bertholf, who continued his studies this summer at the Bee Culture Laboratory, on the reaction of bees to light of various wave-lengths and intensities, resigned his temporary appointment on September 10th to resume his duties as Professor of Biology, at Western Maryland College, Westminster, Md.

Mr. J. Wayne Beatty, has been granted a honey inspector's license which authorizes him to inspect, sample, grade and certify to the condition of extracted honey for warehouse storage in Fargo, North Dakota. This certificate is in compliance with the United States Warehouse Act and is sent by the officials of the United States Department of Agriculture.

At the recent meeting of the Louisiana State Beekeepers' Association the following officers were elected: president, Mr. W. E. Anderson, State Entomologist, Baton Rouge, La; vice-president, Mr. L. J. Bond, St. Francisville, La.; secretary-treasurer, Prof. O. E. Rosewall, Department of Zoology, University of Louisiana, Baton Rouge. One of the chief topics of discussion was the development of a marketing scheme.

Dr. A. P. Sturtevant, in charge of the United States Intermountain Bee Culture Field Station, at Laramie, Wyoming, spent several days the week of August 20th at the Bee Culture Laboratory, Somerset, Md., conferring with members of the staff about the work of the Laramie Station. He returned to his station on August 27. While here Doctor Sturtevant also made a study of Septicemia, a disease of adult bees recently discovered by Dr. C. E. Burnside. It is thought that this disease exists in the Intermountain States.

The meeting of the Southern States Beekeepers' Conference held at Texarkana, Texas, on August 6 to 7, resulted in the election of the following officers: president, Mr. W. E. Joor, Dallas, Tex.; vice-president, Mr. Jes. Dalton, St. Francisville, La.; secretary, Mr. W. E. Anderson, State Entomologist, Baton Rouge, La. The next meeting is to be held at Baton Rouge the latter part of February. It is the aim of this conference to afford a common meeting ground for discussing problems which are peculiar to southern beekeeping conditions.

The Bee Culture Laboratory, of the Bureau of Entomology, through various sources has been informed that foreign buyers of honey, particularly in Germany, are complaining that much of the honey received from the United States is overheated to the extent that the diastase is destroyed. In order to avoid criticism and to facilitate the marketing of our honey in Germany, beekeepers and honey packers are warned to apply a minimum amount of heat. Not only is there danger of impairing both the flavor and color of honey by the application of too much heat but heating also retards granulation, and it is well known that shipments of honey will arrive at their destination in much better shape if the honey is solidly crystallized.

A very peculiar situation has arisen in the apiary of the Bee Culture Laboratory, of the Bureau of Entomology, this summer. Ordinarily after the honey-flow from the tulip-tree is over the bees gather very little until golden-rod and aster are in blossom. This year, however, during July the bees made about 1-½ supers of honey, presumably from sweet clover. This honey granulated immediately even before the cells are filled. Granulation is so solid that it is impossible to throw out the honey with an extractor. In order to salvage anything at all from these supers it will be necessary to cut out the combs and melt the wax and honey. Beekeepers in this section of the country will have to take particular care to see that this honey is not left on the colonies for winter stores. Samples of honey have been sent to the Bureau of Chemistry and Soils for analysis.

The new Southern States Bee Culture Field Station, of the Bureau of Entomology, of the United States Department of Agriculture, was opened on July 16th at Baton Rouge, La., with Mr. W. J. Nolan, acting temporarily in charge. The University of Louisiana is supplying laboratory quarters, heat, light, janitor services, and other facilities, which mean a considerable saving to the Department of Agriculture. Dr. W. W. Whitcomb, Jr., who received his doctor's degree at the University of Wisconsin and was recently engaged in entomological work for that state, accepted a position as Assistant Apiculturist with the United States Bureau of Entomology on July 18th, and after spending a couple of weeks at the Bee Culture Laboratory, in Washington, left for Baton Rouge, where he took charge of the Field Station upon the return to Washington of Mr. Nolan on August 30. The new station will undertake to study the advisability of establishing standard grades for package bees and queens, as well as to study the problems of commercial honey production peculiar to the South, and make a survey of the principal honey flora of that region. Mr. Nolan spoke about this new field station before the Louisiana State Beekeepers' meeting on July 25 to 26, and the Southern States Beekeepers' Conference at Texarkana, Tex., on August 6 to 7, as well as participating in the beekeeping program of Farmers' Week held by the University of Florida, at Gainesville, Fla., from Aug. 13 to 18. Doctor Whitcomb also attended the Texarkana meeting. On the return from the Texarkana meeting, Doctor Whitcomb and Mr. Nolan, in company with Mr. Jes Dalton for the past few years president of the Louisiana Beekeepers' Association, made a survey of the package bee business around the Hamburg center in Avoyelles Parish in Louisiana.

Notes on Medical Entomology

Dr. F. C. Bishopp and Mr. O. G. Babcock of the Bureau of Entomology, visited the Kansas State Agricultural College on April 17th and went over the results of the experiments on the use of Volck in the control of certain external parasites.

Early in July H. M. Brundrett, of the Bureau of Entomology, left Dallas, Texas, for Schenectady, N. Y., to conduct investigations on the cattle grub. The work was shifted later to Herkimer, N. Y., and Mr. Brundrett has now returned to Dallas. He stopped over in Washington enroute in both directions.

On July 6 a conference was held in Dr. A. F. Woods' office, to discuss the problem of the cattle grub, and the work on that insect proposed by the Bureaus of Entomology, Animal Industry, and Chemistry and Soils. Representatives of a number of industries interested were present as well as representatives of the bureaus mentioned.

Mr. Eric Hearle attended meetings held under the auspices of the British Columbia Stock Breeders Association and the British Columbia Wool Growers Association, at Kamloops, early in June, where he discussed various insect problems affecting sheep raising. Mr. Hearle is making a survey of the tick fauna in southern British Columbia. He is also making a study of repellents suitable for protecting dairy cattle from the attacks of biting flies. On June 20, Mr. Hearle addressed the Rotary Club at Kamloops on the control of mosquitoes.

In July R. W. Wells, a former employee of the Bureau of Entomology was appointed Associate Entomologist, and Harold S. Peters and Emory C. Cushing Assistant Entomologists. Mr. Wells has been following commercial work since his resignation from the Bureau several years ago. He and Mr. Peters are now carrying on cattle grub investigations at Herkimer, N. Y. Mr. Cushing is temporarily assigned to studies on mosquitoes, with headquarters at Mound, La. David G. Hall, a temporary appointee, has been assigned to investigations of the cattle grub.

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SOME PHASES OF THE JAPANESE BEETLE INSECTICIDE INVESTIGATIONS[1]

By E. R. VAN LEEUWEN, *Associate Entomologist*, O. G. ANDERSON and
P. A. VAN DER MEULEN, *Agents, Bureau of Entomology,*
United States Department of Agriculture

ABSTRACT

Effective measures for the protection of many economic plants from injury by the Japanese beetle (*Popillia japonica*) have resulted from insecticide investigations. Various factors influencing the results of insecticide experiments are discussed. Data are given to show that certain non-toxic materials are as effective in repelling beetles as lead arsenate, indicating that other factors besides toxicity are responsible for the repellence of the lead arsenate sprays. The great difficulty in obtaining a high mortality of beetles with a stomach poison has been, first, to get the beetles to come to poisoned foliage, and, second, to get them to eat the poison. Progress in this connection is reported, together with methods for killing beetles otherwise than by the use of a stomach poison. In cases of heavy infestation there is some doubt whether a large percentage of kill and a high degree of protection can be obtained by means of a stomach insecticide.

Since the Japanese beetle was first discovered in this country insecticide investigations have been carried on by several men for the purpose of developing methods for its control. The earliest reports on these studies indicated that the beetles were difficult to poison, and were repelled by most arsenical sprays. These facts, and the evidence that, unless the beetle was checked, it was likely to become a pest dangerous to most of our economic plants, made it very important to find a means for successfully combating it. Entomologists working for the control of the Japanese beetle have considered the application of chemicals the most promising means available, as that is usually accepted as one of the most satisfactory methods in the control of the insect pests. In the course of these investigations considerable progress has been made in developing measures effective from the standpoint of protection. This paper reports the present status of the problem of insecticides as related to the Japanese beetle, and describes several of the more valuable methods for the protection of plants and the destruction of beetles.

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[1] Contribution No. 28 of the Japanese Beetle Laboratory, Moorestown, N. J.

From a small number of beetles first found in the Riverton area in 1916, the insect has become very abundant until, at present, many millions could be collected; and severe injury to many plants is often inflicted in a very short time. This condition has made it necessary from time to time to issue recommendations for the guidance of the public. These cover certain spraying methods, and are being followed extensively, with high success, over a wide area of the heavily infested territory. There is no doubt concerning the degree of protection that is afforded to plants, provided the recommendations of the Laboratory are followed. The results of many field tests, over a period of years, have demonstrated this conclusively. Better protection and control with insecticides are obtained against the Japanese beetle than against many other insects which have for years received the attention of entomologists. By this statement the writers do not mean to imply that this insect is an easy one to control, but that, as far as protection of crops is concerned, the insect is controllable. In combating it attention must be given to several details, such as timeliness and thoroughness of application of the spray. These factors are even more important in the control of the beetle than they are in controlling many other important orchard insects with which the writers have had experience.

With the exception of early peaches and the bloom of certain flowering plants, for the past three years apple, late peach, cherry, and plum orchards, shade trees, shrubs, vineyards, and gardens have been treated, and there has been very little injury by beetles where the treatment was applied in accordance with established methods (Plate 18, fig. 1). Although numerous experiments have been tried, no satisfactory method has yet been worked out for the protection of early peaches or the bloom of certain flowering plants.

The difficulty in control in early peach orchards is that the beetles are greatly attracted to the ripening fruit, which is harvested at this time. Large numbers of beetles literally swarm to this fruit and the protective coating resulting from the spray is destroyed by the first beetles which feed on it. Furthermore, sprays applied at this time leave a heavy deposit of residue which cannot be removed without injuring the fruit for market. Peaches with large quantities of spray residue have very little market value, and are subject to Government regulation.

The problem of the protection of certain flowers is to keep the expanding flower covered with poison, as newly uncovered areas are constantly being exposed to attack. This is a very favorable condition for the beetle, as it is often attracted to flowers. In order to protect the flowers completely from injury it would be necessary constantly to apply poisonous sprays, which, of course, is hardly practical. It was hoped that a suitable repellent might be of value in protecting early peaches and flowers, but none has as yet been found. Although much information has been accumulated, the results, to date, are mostly negative. Emphasis, however, is being placed on this phase of the investigations.

As the beetle continues to spread into new territory new problems of control are arising. In the past season beetles were becoming very numerous in cornfields in eastern Pennsylvania and southern New Jersey. They attack the tassel, leaves, and silk, and, where the corn has not been fully pollinated before injury has resulted, considerable damage may be caused to the developing ear from the destruction of the silk, of which the beetles are especially fond. Neither the percentage of injury nor the extent to which the beetle can injure a corn crop has been fully determined, and it is still a question whether it is sufficient to warrant the cost of remedial measures. It is the writers' opinion that most of the corn grown in the present area of infestation will be pollinated, in an average year, before injury to the silk occurs. Experiments with dusts were conducted in a cornfield during the past season. Many dead beetles were observed after the dust was applied, and the field was found to be entirely rid of living beetles, but further work will have to be done before definite conclusions are drawn.

This year, for the first time, beetles were reported to have injured blackberries and raspberries in the Hammonton district and other districts in New Jersey. The protection of such crops presents new and different problems, because it is the ripening fruit that is most subject to attack.

One of the chief factors which, in spite of countless numbers of beetles, makes it possible to secure protection with heavy applications of poisons high in toxicity, is that they have a more or less repellent effect on the beetle. The repellent effect of the various sprays has been very noticeable, and has received considerable attention from several individual workers. There is never an accumulation of beetles on the sprayed plants, such as is often found on the unsprayed plants. The reason, or reasons, for this is not known, beyond the fact that several factors are responsible. The first information as to why the beetle is repelled from arsenical sprays was published by Moore,[3] in which he states that "Japanese beetles are not repelled from sprayed foliage by the color, physical condition, or taste of the arsenical," but that "the beetles appear to be repelled by the toxic symptoms resulting from eating some of the arsenical" As this was the only information which had been published at the time the writers were assigned to these insecticide investigations, it was from this point of view that the work was begun. Their problem was to mask the toxicity of lead arsenate in such a way that beetles would consume a toxic dose before they were repelled. Work was begun by confining beetles in small cages where they were allowed to feed upon plants sprayed with various mixtures of lead arsenate and insoluble soaps. One of the results of this work was the development of an insecticide known as coated lead arsenate, which has been used in great quantity throughout the beetle areas, and is there being recommended for the protection of shade trees and shrubs. It is a combination of ordinary acid lead arsenate paste and a coating of 2 per cent lead oleate. Approximately 70,000 pounds of coated lead arsenate was used for beetle control during the season of 1927.

The cage tests with coated lead arsenate gave a much higher percentage of kill than did similar tests with ordinary lead arsenate, but, unfortunately, in the field the beetles were not attracted to the sprayed foliage as readily as they were to unsprayed foliage. Under field conditions the results from coated lead arsenate were in many ways far superior to those from ordinary lead arsenate. There appeared to be little difference in the number coming to the coated lead arsenate and the number coming to trees treated with uncoated lead arsenate, although those coming to the former remained for a longer time. It was apparent, therefore, that toxicity was not the only factor which influenced the repellence of beetles from foliage sprayed with lead arsenate. The writers therefore made a study of the reaction of the beetle to several toxic and non-toxic materials, in order to ascertain whether other factors played any part in the repellence. From the results of extensive experiments continued over a period of three years it was found that the efficiency of several materials in repelling beetles from foliage, unsprayed foliage being used as check, was as follows:

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[3] Moore, William. The reaction of the Japanese beetle to arsenical spray deposits. Jour. Econ. Ent., Vol. 15, No. 1, February, 1922, pp. 67–71.

	Per cent
China clay	87.1
Acid lead arsenate	77.4
Chalk	74.4
Calcium arsenate	71.3
Slaked lime	69.1
Basic lead arsenate	60.8
Lead arsenate colored green	39.0
Barytes	37.8

In these results it will be noted that beetles were repelled from some materials which were not toxic. Observations made when these data were being obtained indicated that the more conspicuous the appearance of a material on a plant, the more repellent the material was to the beetle, regardless of its toxicity. Under conditions of extremely heavy infestation beetle injury may occur in spite of poisonous sprays. It is therefore apparent beyond a doubt that toxicity is not the only factor accountable for repellence. Further study of the reaction of the beetles to spray deposits brought out the fact that the beetles not only do not alight upon sprayed trees so readily as they do upon unsprayed trees, but that they do not even approach them.

The attraction that an accumulation of beetles exerts upon other beetles in the near vicinity has been noted many times. Two plants or two trees are often seen within a short distance of each other, one heavily infested, the other entirely free of beetles. The reason for this is readily shown by the results of an experiment in which beetles were counted and removed from foliage as fast as they arrived, and in which at the same time counts were made of beetles coming to foliage where they were permitted to accumulate. In this experiment 43.6 per cent more beetles came to the foliage upon which they were allowed to accumulate than to the foliage from which they were removed. The attraction of an accumulation of beetles, is, therefore, another factor influencing control. If an accumulation of beetles could be maintained on a tree sprayed with lead arsenate many would be killed. This has been demonstrated by spraying a heavily infested tree with a light application of lead arsenate, less repellent than the heavier applications apparently necessary to insure protection.

Acid lead arsenate, when applied as directed by the Laboratory, will kill an average of 30 per cent of the beetles that are on the plant at the time of spraying and of those which come to the plant while a heavy deposit of poison remains. This figure was obtained by collecting beetles as they left the sprayed trees and observing their mortality for a period of 48 hours. (Plate 18, fig. 2.) Other methods were employed, such as surrounding a sprayed tree with a large screen cage, and collecting all beetles when they left the tree and flew to the sides of the cage. Beetles are very active in the field, where they often fly from one tree to another and feed a little on each. In a well sprayed area many are thus killed during the season by the cumulative effect of the poison in their system. Since many beetles leave both sprayed and unsprayed trees without feeding, the percentage here given is the minimum which can be expected from lead arsenate sprays.

The results of the insecticide studies at the Laboratory prove conclusively that the protection afforded by spraying with arsenicals high in toxicity is due mostly to the repellent action of the poison, and is not the result of the actual killing of large numbers of beetles. In spite of this difficulty the greatest efforts have been made to increase the kill. Although the writers appreciate the fact that the most important reason for spraying is the protection of the plant, they have a strong desire to accomplish three things, first, to induce as many beetles to come to sprayed foliage as come to similar unsprayed foliage; second, to induce at least 60 per cent of them to consume a fatal dose of poison; and, third, to develop a quick acting poison which will result in the appearance of a large number of dead beetles below the sprayed plant.

Geraniol, a colorless, oily liquid with a rose-like odor, is, under certain conditions, attractive to the Japanese beetle. This attractiveness was tested in an experiment in which it was emulsified, mixed with a lead arsenate spray, and applied to foliage. There was evidence, however, that the beetles fed very little on the poisoned foliage and that very few were killed. The geraniol appeared to excite them to activity; many which were attracted failed to alight, but flew to neighboring unsprayed trees. They continued to come and go for a period of about 20 minutes after the application and at the end of that time many more were leaving than coming. To overcome the rapid dissipation of the geraniol when applied as a spray, and to maintain a constant odor, a small apparatus known as an odorizer was developed, which permitted the geraniol to drip continuously upon a sponge. Several odorizers were distributed in an orchard which had previously been sprayed with a heavy application of lead arsenate. Many of the beetles attracted to the sprayed trees were killed, and were counted during a period of several days as they fell upon a piece of canvas spread upon the ground. Considerable injury to the fruit and foliage of several apple trees, caused by feeding, was noted. In the case of the fruit, the first beetles attracted destroyed the protective coating left by the spray, and those

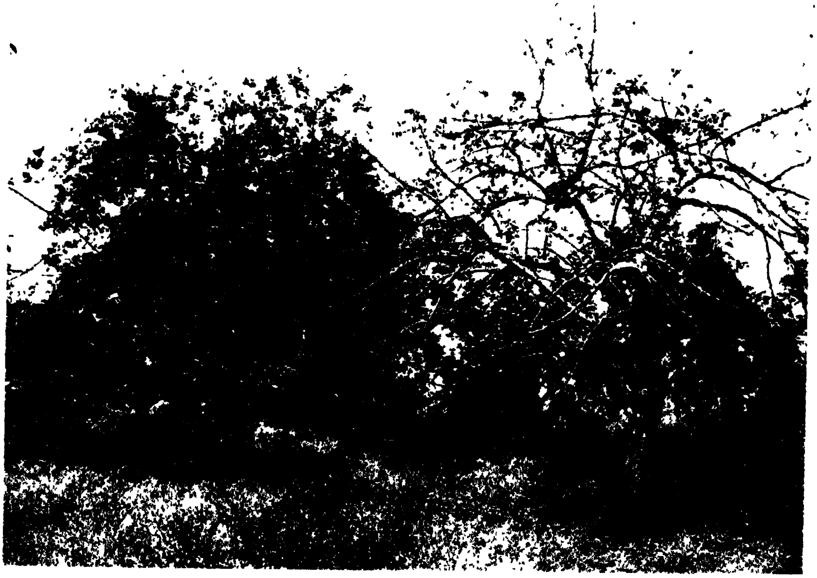

FIG. 1.—Sprayed and unsprayed trees.

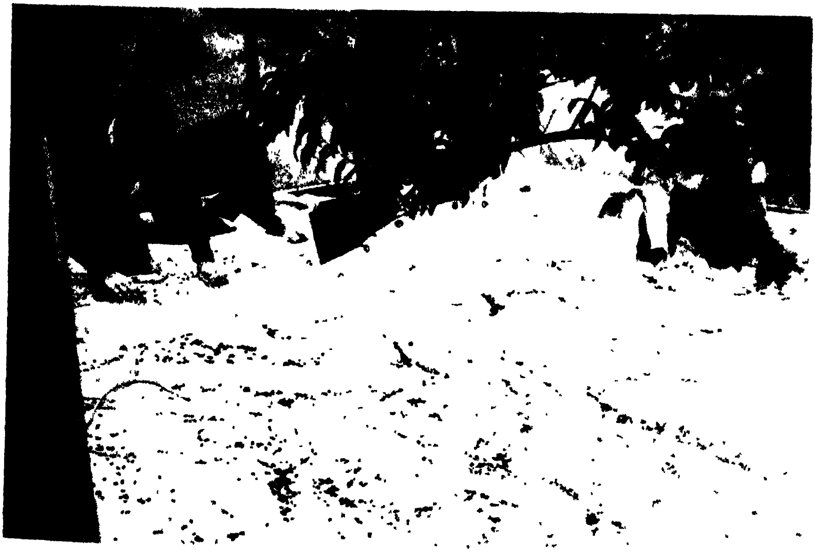

FIG. 2.—Beetles killed by lead arsenate sprays.

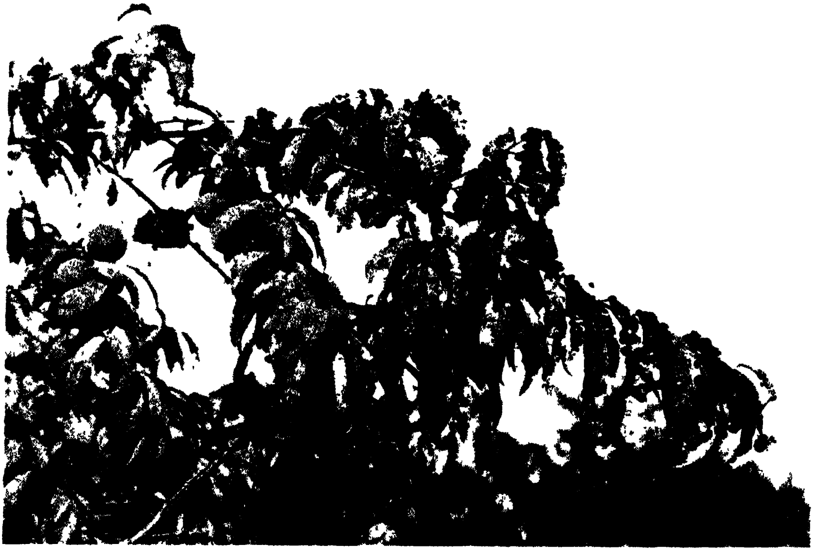

FIG. 3.—Beetles feeding on sprayed foliage after being attracted by geraniol.

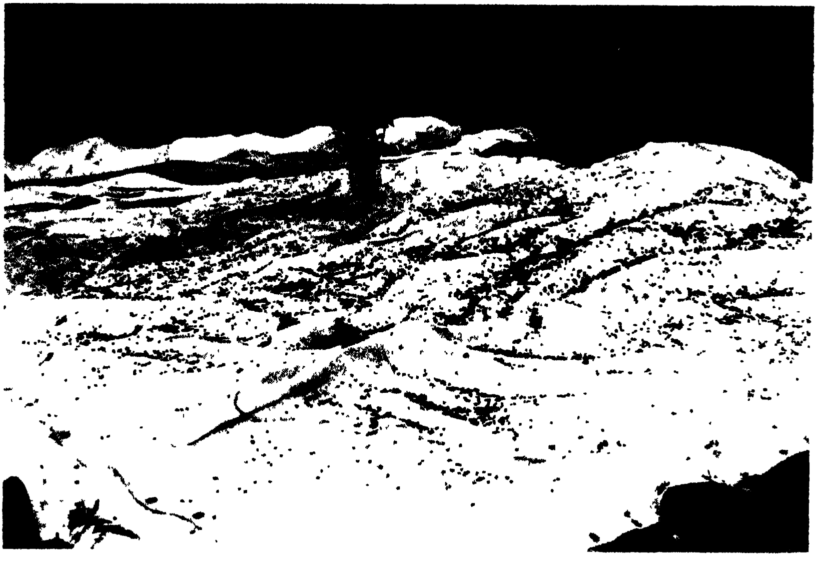

FIG. 4.—Beetles killed by a contact spray after being attracted by geraniol.

which came later accumulated on the fruit and destroyed the entire crop of several trees. Moreover, the method did not appear to make the lead arsenate any more palatable to the beetle. More injury was caused by feeding, and there were larger numbers of dead beetles present, owing to the attraction of larger numbers of beetles to the tree.

In the course of these and other experiments it was observed that it was necessary not only to attract the beetles to the sprayed trees but to induce them to feed more upon the poison. Various fruit juices and flavors were therefore used in combination with the lead arsenate. The most outstanding discovery which resulted from these experiments was that the beetles would gorge themselves upon foliage, sprayed with lead arsenate and a solution of refined sugar, on a tree to which they were attracted with geraniol. (Plate, 19, fig. 3.) A higher proportion of beetles fed on this foliage than on similar unsprayed foliage, and the kill was much higher than has ever been obtained with any other insecticide used in the field against the beetle. Work is under way to determine the insecticidal value of various sweetened materials, their adaptation to beetle control, and their effect upon plant growth. A combination of geraniol, to attract the beetles, with a poisonous spray which they will eat readily is a promising method for killing them.

While working with insecticides in an area of heavy infestation it has been clear that it would be very difficult to kill a large percentage of beetles with a stomach poison and, at the same time, to avoid severe injury caused by the feeding of the beetles upon fruit and foliage. This difficulty, together with the fact that only a small portion of the beetles attracted to poisoned foliage are actually killed, made it necessary to develop other methods. One was to apply a contact spray after the beetles had become concentrated on a comparatively small area. Several preliminary experiments were made with a spray composed of sodium oleate and an alcoholic extract of pyrethrum, applied with a bucket pump to beetles which had been attracted to peach trees. The beetles were easily disturbed by the spray, and many of them flew away before receiving a sufficient quantity of it to prove fatal. It was later observed that if geraniol were applied to a tree separated from an orchard or from other trees by a distance of 100 yards or more, beetles collected upon it in great numbers, where they could be readily killed with the contact spray. (Plate, 19, fig. 4.) These experments were followed by one on a much larger scale, in which four large power sprayers, each operated by a crew of five men, were employed in a very heavily infested area three square miles in extent, to determine if the number of beetles could be reduced. The sprayers were capable of distributing 45 gallons per minute when operated at a pressure of 500 pounds to the square inch. By using with each outfit two nozzles with spreaders, one on each side of the infested tree, and by directing the spray in the shape of a fan from the top of the tree downward, few beetles were able to leave without becoming thoroughly wet. This method proved very satisfactory but, as the beetle is a strong flier, it does not prevent the area from becoming reinfested. Where it is impossible to employ sprayers of the high-powered type, a more simple method is quickly to cover the infested tree with a tent, from within which the contact spray is applied with a bucket pump. Either of these methods is satisfactory provided a well-organized campaign is conducted over a wide area. The only disadvantage now apparent is that geraniol cannot be relied upon to attract beetles under all conditions. To obtain the best results from its use it should be applied when the beetles are most active, which generally occurs under conditions of bright sunshine and high temperature; the latter should be at least 80 degrees F. Other factors favorable to the use of geraniol are a relative humidity of between 40 to 70 per cent, a slight breeze, and a low vapor pressure. As such conditions occur in New Jersey during the beetle season only between the hours of 10 A. M. and 4 P. M. the time in which the method can be applied is very short.

Many beetles were caught during the past season in so-called "hooch" traps, which are small, wide-mouthed receptacles containing fermented apple juice. The bait used was of the kind recommended by Spuler[8] in his work with the codling moth in the Northwest. It was made by mixing 20 gallons of apple juice, 2 pounds of raisins, 20 pounds of sugar, and 18 yeast cakes. The mixture was allowed to stand for two weeks while it was fermenting. Two-quart galvanized stew-pans were two-thirds filled with the bait and hung in infested peach trees. From 20 of these pans 47,350 beetles were collected during a nine-hour period of beetle activity.

Experiments have been made with many types of apparatus for catching beetles. The most effective trap, and for use with it a bait containing geraniol as the chief ingredient, were devised by members of the Laboratory staff, and were first used by the public last season. This trap, and others which are modifications of it, are manufactured by several commercial firms. These traps are very promising as devices

[8] Spuler, Anthony. Moth trapping is well worth while. Better Fruit, Vol. 21, No. 12, June, 1927, pp. 9–13.

for destroying beetles, and large catches in them have been reported. The writers gave considerable time and thought to the improvement of the trap now in use, and some interesting results were obtained. Their effort is to devise a trap which will capture most of the beetles that come to it.

It is very apparent to the writers that, in cases of heavy infestation, any insecticide used must serve either for the protection of the plant by repelling the beetles, or for the killing of beetles without regard to protection. No method has ever been observed whereby large numbers of beetles are killed and a high degree of protection is also secured at the same time.

SOIL INSECTICIDES FOR THE JAPANESE BEETLE[1]

By WALTER E. FLEMING, *Associate Entomologist, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

A brief summary of the materials which have been tested to determine their effectiveness for destroying the beetle in the soil about the roots of nursery plants.

In the development of methods for sterilizing the soil about the roots of growing nursery plants within the Japanese beetle area, one of the first steps was to determine what chemicals could be used to destroy the eggs, larvae, and pupae of the beetle. The results of several years' experimentation indicate that the soil-infesting stages of the insect can be killed by treating the soil with certain organic gases, solutions, or solids. The most effective of these compounds are treated briefly in this paper.

FUMIGANTS

Carbon disulfide was one of the first organic compounds to be used successfully in the form of a gas against the beetle in the soil. A saturated atmosphere of this chemical at room temperatures will kill the larvae, and prevent the eggs from hatching, when they are exposed to its action for a few minutes. A concentration of 4 parts of carbon disulfide in 100,000 parts of air is lethal to these stages within 24 hours, at 80° F. As the temperature is decreased, it is necessary to prolong the exposure to obtain the desired mortality. At a temperature of 60° F. a minimum period of 72 hours is required, and at 40° F. a minimum period of 120 hours must be used, to insure the destruction of the insect.

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[1] Contribution No. 32 of the Japanese Beetle Laboratory, Moorestown, N. J.

As there was an abundance of data on carbon disulfide as a fumigant for the soil-infesting stages of the Japanese beetle, this substance was chosen as a standard of comparison in determining the effectiveness of the other organic compounds.

Because of the fact that a relatively large number of compounds was to be tested for possible value as soil-fumigants, it was decided so to conduct the tests that a general idea might be obtained of their toxicity to the larvae. No attempt was made to determine the exact toxicity of any compound. In the first series of tests naked larvae were exposed to the vapors evolved from different weights of the chemicals in air of 70 per cent relative humidity. As the tests were made at about the same temperature on compounds differing greatly in vapor pressure, the more volatile could be tested in several concentrations, whereas the slightly volatile could be tested only in the maximum concentration of the vapor which was possible at the temperature of the test.

The results of the fumigation of naked larvae at room temperature indicated that the following compoundswere more toxic than carbon disulfide:

Benzyl chloride
Mustard oil
Hydrocyanic acid
Naphthalene
Ortho-cresol
Para-toluidine
Phenol
Nicotine
Ortho-toluidine
Aniline
Ethyl formate
Nitrobenzene
Para-dichlorobenzene

In a second series of tests, moist soil was infested with larvae, compacted loosely in standard cylindrical wire baskets, and exposed, in an atmosphere containing 70 per cent relative humidity, to the vapor evolved from the most toxic fumigants. It was found that among the larvicides carbon disulfide alone could be depended upon to permeate the soil and destroy the insects within twenty-four hours. The lachrymatory vapors—benzyl chloride and mustard oil—did not penetrate in effective concentration beyond a thin superficial layer of the soil. Hydrocyanic acid, nicotine, furfural, formaldehyde, phenol, and ethyl formate, which are relatively soluble in water, were apparently absorbed by the moisture near the surface, and did not permeate the mass of soil. The other vapors penetrated in effective concentration only when the treatment was prolonged for several days.

Many organic compounds are toxic in their vapor state, but, because of their reactivity with the constituents of the soil, do not penetrate in insecticidal concentration. Others have, at soil temperatures, such a low vapor pressure that they permeate the mass of soil very slowly.

It is necessary to know the conditions under which the soil must be sterilized. If complete fumigation within a few hours is desired, carbon disulfide is possibly the most effective and reliable compound which can be employed. If the treatment is to be prolonged over several days or weeks, however, it might be better to use a compound of low vapor pressure, like naphthalene, para-dichlorobenzene, or para-toluidine, the vapor of which can be maintained at a killing concentration for a much longer period of time.

SOLUTIONS

A dilute emulsion of carbon disulfide has proved to be one of the best insecticides for the soil-infesting stages of the Japanese beetle. When submerged in the emulsion, the following concentrations of the toxic agent were normally required to kill these stages of the insect within 24 hours, at a temperature of 65°F.:

Eggs	0.01 per cent
First-instar larvae	0.02 " "
Second-instar larvae	0.03 " "
Third-instar larvae	0.03 " "
Pupae	0.04 " "

In obtaining satisfactory results there is, however, a close relationship between the temperature of the solution, the concentration of the toxic agent, and the duration of treatment. If the temperature is low, it is possible to some extent to compensate for the resulting loss in insecticidal action by increasing the concentration of the toxic agent, by prolonging the time of treatment, or by increasing both factors. With dilute carbon disulfide emulsion, which was taken as a standard with which to compare the other solutions, the most satisfactory results were obtained at a temperature of 65° to 70°F., with the treatment prolonged for 24 hours.

As the number of compounds under consideration was very large, only the relative toxicity of their solutions at different concentrations was determined. The substances included organic hydrocarbons, bromides, chlorides, alcohols, aldehydes, esters, nitro-compounds, amino-compounds, ethers, sulfur compounds, and essential oils. In the first series of tests, naked larvae were submerged in the solutions, at a temperature of 65°F., for a period of 24 hours.

It was found that solutions containing the following chemicals were more toxic under these conditions than was one containing carbon disulfide:

Mustard oil
Wormseed oil
Benzyl chloride
Hydrocyanic acid
Bromobenzene
Hexachloroethane
Naphthalene
Pentachloroethane

In a second series of tests, moist soil infested with beetle larvae was treated by two methods. In the first, it was submerged in the solutions, which were of different concentrations, for a period of 24 hours; in the second, the solutions were poured on the surface of the soil, and allowed to percolate through it. When the infested soil was submerged in the solution it appeared that effective insecticidal action was dependent, to a large extent, upon its bulk, composition, and condition. If the condition of the soil is favorable for penetration by the solution, the insects can generally be killed by submerging the soil in any of the solutions mentioned above, except those of hydrocyanic acid and of benzyl chloride, which did not give uniformly good results, even under optimum conditions. If the soil is in poor condition for treatment, however,—too wet, too dry, too cold, too rich in organic matter, too compact, etc.,—the insects may survive submersion in any of the solutions.

When poured upon the surface of infested soil and allowed to percolate through it, a larger volume of the toxic solution can be passed through the infested mass, and a greater concentration can be obtained than in soil submerged in the solution. While several of the solutions gave satisfactory results, carbon disulfide emulsion was found to be equally effective and much less expensive.

Solids

Tests were begun three years ago to determine which organic compounds, solid under ordinary conditions, could be mixed with soil to destroy the beetle. A group of these compounds, including hydrocarbons, alcohols, nitro-compounds, amines, sulfur compounds, chlorides, and bromides, was selected for investigation. Soil which had been intimately mixed with different quantities of the compounds was infested with larvae, and was examined at weekly intervals to determine their condition. Some of these compounds, which may act either as fumigants or as stomach poisons, destroyed the larvae. The following table gives, approximately, the minimum concentration and the minimum period of time necessary to kill the insects with each of the most toxic compounds:

Hydroquinone	0.03 per cent. effective within 1 week.
Naphthalene	
2–4 Dichloroaniline	0.16 per cent. effective within 1 week.
Trichloroaniline	
Ortho-nitrochlorobenzene	
Para-nitrochlorobenzene	
Ortho-toluidine hydrochloride	
Xylidine hydrochloride	
Alpha-naphthylamine hydrochloride	
Beta-naphthylamine hydrochloride	
Alpha-naphthol	
Beta-naphthol	
Para-nitrophenetol	
2–4 Dinitrophenol	
Beta-naphthylamine	
Para-toluidine	
Meta-dinitrobenzene	
3-Nitro-4-amino-toluene	
Alpha-nitronaphthalene	
Nitro-naphthylamine	
Diphenyl	
Potassium xanthate	
Acetyl ortho-toluidine	0.16 per cent. effective within 2 weeks.
Dibromonaphthalene	
Para-chloroacetanilide	
Alpha-naphthylamine	
Di-nitrotoluene	
Diphenylamine	
Aniline oxalate	0.16 per cent. effective within 3 weeks.
Benzoyl-alpha-naphthylamine	
Alpha-naphthoic acid	
Meta-nitroaniline	
Aniline hydrochloride	0.33 per cent. effective within 1 week.
Acetyl-para-toluidine	0.33 per cent. effective within 2 weeks.
2-4 Diaminochlorobenzene	0.33 per cent. effective within 3 weeks.
1-Nitro-2-naphthol	
Sodium-1-naphthol-4-sulfonate	
Beta-naphthalene sulfochloride	0.5 per cent. effective within 2 weeks.
Para-nitrophenol	
Para-aminoacetanilide	0.5 per cent. effective within 3 weeks.
2-6-Dichloro-4-nitroaniline	
Oxanilide	
Diacetyl-ortho-phenylenediamine	0.66 per cent. effective within 3 weeks.
Ortho-aminophenol	
Anthraquinone	
Beta-naphthyl benzoate	
Tolidine	

SOIL TREATMENT IN GENERAL

The use of chemical soil insecticides is generally restricted to well-drained soils of medium texture which are neither too wet nor too dry, too rich nor depleted in organic matter, too warm nor too cold. Uniformly good results can be expected only in soils in which the proper dispersion of the toxic agent is assured. It is equally important to have the soil in suitable condition, and to choose the proper insecticide.

The insecticidal action of the compounds has been considered under optimum conditions only in this paper. The determination of the gases, solutions, or solids which can be used to kill the beetle in the soil, however, is only one important step in the development of a method for sterilizing the soil about the roots of a growing plant. Before an insecticide can be considered commercially it is necessary to know how effective it will be under different soil conditions and at various times of the year. It is necessary to ascertain the effect of the treatment on the fertility and the physical and chemical properties of the soil. The immediate and the subsequent effect of the treatment on the development of the plant must also be studied in order to determine when the plants can be treated with least injury by the insecticide. At the present time the problem is to find that insecticide, for each particular crop, which will kill the insects in the soil with the least deleterious action on the plants.

HOT WATER AS AN INSECTICIDE FOR THE JAPANESE BEETLE IN THE ROOTS OF NURSERY STOCK[1]

By WALTER E. FLEMING, *Associate Entomologist*, and FRANCIS E. BAKER,
Junior Entomologist, Bureau of Entomology,
United States Department of Agriculture

ABSTRACT

Hot water is an effective dip for killing the eggs, larvae, pre-pupae, pupae, and adults of the Japanese beetle (*Popillia japonica*) in the soil. A temperature of 112°F. is the lowest which will give dependable results within a practical period of time. This temperature is recommended for the treatment of soil about the roots of nursery stock, to destroy the soil-infesting stages of the beetle.

An investigation is now under way to determine what varieties of nursery stock can be treated with hot water, and the optimum time of year for applying the treatment with least injury to the plants.

INTRODUCTION

Hot water seems promising as an insecticidal dip for the soil about the roots of nursery plants grown within the Japanese beetle area. Its use is one of the most simple and certain methods for killing insects in the soil; it is easily and cheaply applied to practically all types and conditions of soil, and it appears to be no more injurious to the roots of plants than the chemical treatments which have been employed for this purpose.

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[1] Contribution No. 33 of the Japanese Beetle Laboratory, Moorestown, N. J.

The principal work to determine the value of hot water as an insecticide was begun in the fall of 1926, and will be continued for at least another season. Since the results obtained during the past fall correspond with those of the past year, it was decided at this time to present a preliminary report on the treatment, before the completion of a second year of experimentation. The effects of the hot water treatment on nursery plants will not be discussed in this paper, as it is necessary to limit it to the insecticidal phase of the investigation.

The treatment is to be used as a quarantine measure for preventing the artificial dissemination of the insect in soil about the roots of nursery plants. It was necessary to use large numbers of insects to determine definitely the temperature and length of exposure that would destroy all stages of the insect throughout the year, because all stages occur in the soil. During 1927 the following individuals have been used in the tests:

Eggs	80,000
1st. instar larvae	15,000
2nd. instar larvae	10,000
3rd. instar larvae	500,000
Pre-pupae	10,000
Pupae	50,000
Adults	500,000

EARLY EXPERIMENTS WITH HOT WATER

Early experiments with hot water showed that all stages of the beetle could be killed by submerging them in water at any temperature over 100° F. When the temperature was below 112°F., however, very prolonged periods of treatment were required, which were less certain in killing the beetle, and, in general, proved more injurious to the plants. As the temperature was increased above 112° F. the insects were killed more readily, but as it approached the thermal death-point of the plant there was more injury, because of the excess heat and the prolonged period of pre-heating necessary to obtain the desired temperature throughout the mass of soil. A temperature of 112° F. was the lowest that gave consistent insecticidal action within a practical period of time. The results which are reported in this paper were all obtained at 112° F.

RESISTANCE OF EGGS

The eggs used in the tests were obtained from beetles kept in standard Reilly cages, about 3,000 in each cage, which was provided with food and a tray of moist, finely-sifted soil. At intervals of about five days these trays were removed, and the eggs were transferred, in groups of 100, to small aluminum tea balls, without soil. They were submerged, in this naked condition, in water at 112°F. for definite periods of time. It was usually possible to obtain a sufficient number of eggs for six to ten tests within a space of a few days.

After the eggs had been submerged for a definite period, they were removed from the container, and placed separately in small depressions on the surface of moist leaf-mold, together with one hundred untreated eggs to serve as a check. They were kept in the dark, and observed daily for a month. When an individual hatched, it was removed from the tray and discarded, to prevent confusion in subsequent observations. A daily record was kept, showing the number of individuals which hatched in each tray and the condition of the unhatched eggs.

The eggs seem to be rather resistant to the insecticidal action of water at 112°F. When they are first found in the soil, in July, a submersion of 55 minutes is necessary to kill them. There is a gradual increase in resistance as the season progresses, and, after the first of August, a treatment of 60 minutes is required.

RESISTANCE OF LARVAE

The larvae were dug in the field in places where they were abundant and free from disease and were brought to the laboratory in boxes containing soil. When treated within a period of 48 hours after being dug, their resistance does not seem to differ appreciably from their normal resistance in the field. If they are stored for several days or weeks before treating, however, their resistance may be abnormal. For this reason they should be treated as soon as possible after removal from their natural environment.

When larvae are removed from soil, they injure each other with their mandibles. It was necessary, therefore, to prevent them from coming into contact with each other during the course of the treatment. A wire cage with separate compartments of about 1 cubic inch capacity was devised for this purpose, and has proven to be very satisfactory for use in treating naked larvae.

Groups of 200 larvae, of the same stage of development, were submerged, each individual in a separate compartment, for different periods of time. They were then removed, and placed upon the surface of moist, freshly-dug soil, and kept under observation for five days. The trays containing the treated larvae were constructed with cross sections, so that it was impossible for them to come into contact with each other. A daily record was kept of the number of larvae which were dead, sick, or normal in each tray. A larva was not considered dead until it remained on the surface of the soil without giving any reaction to external mechanical stimulation, and showed signs of decomposition. It was considered sick when it remained on the surface of the soil, but responded to external mechanical stimulation. It was considered normal if it burrowed into the soil, and, when removed at the end of five days, was apparently unaffected by the treatment.

First-instar larvae are found abundantly in the soil from July 15 until October 15; second-instar larvae are abundant from August 1 until November 1; third-instar larvae are present in large numbers from August 15 until the middle of June of the following year.

First and second instar larvae seem to be quite susceptible to the insecticidal action of water at 112°F., and can be killed at any time by submerging them at this temperature for 30 minutes. The third-instar larvae, which are found in the soil during almost the whole year, show considerable variation in their resistance to the treatment. They can be killed in August and in September as readily as the other larval instars, but after the middle of October they become more resistant. This resistance gradually increases, until in March it is necessary to treat them for 55 minutes. The high resistance continues as long as the ground remains cold. When the ground becomes warmer in the spring, and the larvae become more active and move toward the surface, their resistance decreases very rapidly, until, in June, they can be killed by a treatment of 20 minutes, which is the same as that required in late summer.

RESISTANCE OF PRE-PUPAE

The pre-pupae were dug in the field when abundant, between the middle of May and the end of June, and were treated in the same manner as the larvae. This stage of the insect is more resistant to the action of hot water than is the larva at the same time of year, and an exposure of 40 minutes is necessary to kill it.

RESISTANCE OF PUPAE

The pupae were dug in the field when abundant, during June and the early part of July. They were treated, and then placed on soil the same as the larvae, and were kept under observation for 15 days.

The pupa is one of the most resistant stages of the beetle. It requires an exposure as long as the third-instar larva at its most resistant period, and as long as eggs in the early part of the season. It is necessary to submerge pupae for a period of 60 minutes at 112°F. to assure their destruction.

RESISTANCE OF ADULTS

While the adult cannot be considered a strictly soil-infesting stage, it does spend a considerable part of its life in the soil. After the pupa transforms, the beetle often remains in the soil a number of days, and the female returns several times for oviposition. It is therefore necessary to consider the adult, in this investigation, as a soil-infesting stage of the insect.

The adults were gathered, in the early morning, from unsprayed orchards or fields, and were brought to the laboratory. After being placed in cages, they were submerged in water at 112°F. for different periods of time. They were then removed, and were kept in suitable cages supplied with food, where they were observed until the effect of the treatment was determined.

It was found that the adult is the most easily killed of all stages of the beetle. When it first appears, it can be killed by submergence for 20 minutes. When the period of senility begins, adults become more susceptible to the treatment. As the period progresses, it is possible gradually to decrease the exposure necessary to kill them. At the end of August, adults can be killed by submerging them for fifteen minutes.

TREATMENT OF INFESTED SOIL

Hot water was found to be as effective in killing eggs, larvae, prepupae, pupae, and adults in soil as it was in killing them when they had been removed from the soil. If a mass of soil is submerged, and left until the temperature is 112°F. throughout, and kept at that temperature for a period of time necessary to kill the most resistant stage of the insect present in the soil when the same stage is treated in a naked condition, it is possible to assure destruction of all living forms of the beetle in the soil. The pre-heating necessary to raise the temperature of the mass of soil to 112°F. weakens the beetle, to some extent, and makes it more susceptible to the treatment. The pre-heating period can therefore be considered a safeguard in commercial practice.

PROGRESS WITH THE IMPORTED PARASITES OF THE JAPANESE BEETLE DURING 1927[1]

By H. W. Allen and H. A. Jaynes, *United States Department of Agriculture, Bureau of Entomology*[2]

Abstract

This paper is a progress report on the work of introducing parasites of the Japanese beetle (*Popillia japonica*) during 1927. *Centeter cinerea* increased its area of distribution, but is being imported for further colonization. *Ochromeigenia ormioides* has not yet been recovered, but recoveries were made of both *Prosena siberita* and *Dexia ventralis*. Further liberations were made of these three fly parasites. *Tiphia popilliavora* has increased rapidly from the small beginning previously reported. *Tiphia vernalis* and *Tiphia* No. 1851[3] were liberated in large numbers but have not yet been recovered. Importations have been continued on the Indian Tiphias Nos. 2036 and 2049. Some parasite material was forwarded to the substation at Westbury, Long Island, New York. The paper is concluded with a brief résumé of the work accomplished since 1920.

This paper is a report on the progress during 1927 with the introduction of insect parasites of the Japanese beetle into the New Jersey-Pennsylvania area, and is a continuation of a series of short papers presented in this Journal.[4]

Discussion of the Various Species of Parasites

Centeter cinerea Ald. This tachinid, which oviposits on the thorax of the beetle, was established in 1923, and its known area of distribution has gradually increased. This species was found over an area of approximately 12 square miles in 1924, 48 square miles in 1925, 60 square miles in 1926, and has increased its area to 75 square miles in 1927. At the beginning of beetle emergence the past season, *Centeter* parasitism ran as high as 10 per cent, but dropped very rapidly as the beetles became more abundant. When compared with its status in northern Japan, it has not yet done as well in New Jersey and Pennsylvania as was expected. This parasite may do better as it extends northward. Although parasitism was somewhat higher this season than last, not enough parasitized beetles could be collected for subcolonization. To furnish material for northward colonization, importations were renewed, and 142,000 parasitized *Popillia japonica* beetles were received from Japan for liberations in 1928.

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[1] Contribution No. 24, U. S. Department of Agriculture, Japanese Beetle Laboratory, Moorestown, N J.

[2] Acknowledgments are made to Mr. J. L. King, who is in charge of the parasite work at the Japanese Beetle Laboratory, and to Messrs. J. K. Holloway, R. W. Burrell, M. C. Swingle, and E. T. Lundberg, who, with the authors, assisted in the biological control work reported in this paper.

[3] Laboratory numbers have been used for certain species of *Tiphia* pending their description or definite determination.

[4] See preceding paper by King, J. L., Allen, H. W., and Hallock, H. C., on "The Present Status of the Work on the Parasites of *Popillia japonica* Newman," Jour. Ec. Ent., Vol. 20, pp. 363–373, 1927, for a list of the previous reports.

Ochromeigenia ormioides Tns. This yellow tachinid, a common parasite of *Popillia* in eastern Asia, has not yet been recovered. During the summer of 1927, approximately 15,000 beetles were collected at the colonization point, but no *Ochromeigenia* was obtained from them. Releasements were continued in the usual manner, 731 adults being liberated at the same locality in Riverton, New Jersey. This makes a total of 900 males and 979 females released at this point in the past four years.

Prosena siberita Fabr. This dexiid parasite of the Japanese beetle grub from Japan was for the first time definitely recovered in the summer of 1927, following continuous colonization since 1923. The recovery consisted of two puparia from grubs, and one fertilized female taken within a half mile of the center of the Moorestown, New Jersey, colony. No recovery has been made from the other releasement at Holmesburg, Pennsylvania. Liberation was continued at the Moorestown colony center, mated females being released instead of the unmated adults as in previous years. Altogether 1,888 adults were liberated, of which approximately half were mated females. This season's emergence was 2,024 adults, obtained from 49,000 Japanese beetle grubs. Over a hundred mated females were used to start propagation experiments, which, if successful, will allow the discontinuation of the highly expensive importations of this parasite.

The method of mating in large outdoor cages covered with black mosquito netting, first used in 1926, was continued in 1927, with very satisfactory results. The cages were 8 feet square and 6 feet high. About 700 individuals were confined in each cage, care being taken to confine the females with at least an equal number of males which averaged somewhat older than they.

Dexia ventralis Ald. One of the most encouraging developments of the season was the recovery of this Korean dexiid fly from the point of liberation for the previous season, at Haddonfield, New Jersey. Since it was released as an adult, it must have passed through at least one complete generation in the field. Adults of a second generation were obtained in the insectary, but were never found in the field.

Shipments from the Orient have been continued, five consignments being received from Korea between May 31 and September 6. From these, 2,813 adults were obtained for use at this station, and 2,164, including 1,052 females, were released at a colonization point at Moorestown, New Jersey. The remaining females were used for propagation purposes, and from them approximately 1,700 parasitized grubs were obtained for further work next season.

While it is yet too early to state certainly that this parasite has gained a foothold, two very satisfactory colonizations have been made, and its reaction to the local environment has been most gratifying.

Tiphia popilliavora Roh. This late summer *Tiphia* from Japan, which was recovered for the first time in 1926 over a small area at one location near the Riverton laboratory, appeared in surprising numbers in 1927. This season's adults were found at three of the four colonization points, and the largest colony extended over a square mile. At its center, the adults literally swarmed over the bloom of wild carrot (*Daucus carota*). Their abundance is indicated by the fact that eleven hundred females were obtained for subcolonies, without visible depletion of the "mother" colony. The second largest colony covered about a half square mile.

It is of interest to note that, with this species, definite establishments have been obtained from very small releasements. The largest colony has developed from a few adults of both sexes liberated in 1921 and 1922, which was not detected until four years after liberation. The second largest colony has developed from 45 reared and mated females released in 1922, and 9 in 1923, which is the strongest releasement of imported *popilliavora* ever made at one point. The third establishment resulted from the liberation of 3 females in 1921, and 6 females in 1923. The fourth releasement, from which no recovery has been made, consisted of 43 females somewhat weakened by the long trip from Japan. It was not made until 1925, and is, therefore, three to four years more recent than the known establishments.

In order to hasten the general distribution of this parasite throughout the heavily infested beetle area, subcolonization has been attempted. Basing our judgment on the past success of small liberations, it has been thought best to continue to liberate in relatively small units, and to distribute these as widely over the heavily infested area as our collections will allow. This season, nine sub-colonies, each of 100 field collected-females, were made near the following towns: Collegeville, Emilie, and Bustleton in Pennsylvania, and Ellisburg, Vincentown, Parkville, Berlin, Columbus, and Tabernacle in New Jersey. In addition, 2,957 Japanese beetle grubs containing the eggs of *popilliavora* were placed under the sod in an old orchard near Birmingham, New Jersey. These parasitized grubs were obtained from 100 females collected in the field and maintained in the insectary.

During the winter of 1925–1926, 7,707 cocoons of a Chinese strain of *popilliavora* were received at Riverton. In 1926 none of this material emerged, except from a small portion of the lot forced in a warm room at the end of the season, for experimental purposes. In the winter of 1926–1927 another shipment of 7,910 cocoons was received. During the past summer, 327 adults emerged from the cocoons which had passed through their second winter, but none were obtained from the 1926 material, except a few that were forced. One of the unexpected developments of the season has been this indication of a two-year cycle in New Jersey for a species having, so far as is known, but one in its native habitat, while its Japanese counterpart, with which it is morphologically identical, has only a single-year cycle, both here and in its native habitat.

Two hundred and thirty-two mated females of the Chinese strain, obtained between October 12 and November 22, were liberated at Woodbury, New Jersey. This is rather late for *Tiphia* in the adult stage here, although the same species occurs in the cool fall weather in China. The strain is exceptionally hardy, both in the adult and the cocoon stages, and parasitizes Japanese beetle grubs as readily as the Japanese strain.

Eight hundred and thirty cocoons of a Korean strain of the same species were received early in 1927. From this lot 45 females were obtained, which were mated in the insectary, and released near Moorestown, New Jersey. This strain also parasitizes Japanese beetle grubs quite readily. It has a one-year cycle under insectary conditions in New Jersey, but emerges somewhat later than the established Japanese strain.

Tiphia vernalis Roh. This early spring emerging species from Korea, which was first released in 1925, and for the first time in a large way in 1926, has not yet been recovered after a full generation in the field. However, living pupae from last season's liberations of parasitized grubs were recovered as late as June 7 of this year (1927), and a cocoon from which an adult had emerged was unearthed, although no adults were recovered in the field.

Importations and liberations are being continued as in previous years. Two lots of cocoons, totaling 6,720, were received in the fall of 1926, from which only 332 parasitized grubs were obtained for liberation during the following spring. Shipments of adults have been continued, and this has proved to be, by far, the best way of importing the species. Two consignments were received in June, with 79.2 and 37.7 per cent alive and in good condition on arrival, which yielded a total of 3,736 females. The success in obtaining adults direct from Korea seems quite remarkable, considering the long voyage, and it is due, in a large measure, to the use of an improved shipping container, which carries a solid, non-fermenting food, and a layer of moist soil for shelter.

As we had, for the first time, an abundance of material for liberation, it was thought best to vary the methods of releasement by selecting a number of locations, and liberating both females and parasitized grubs, in order to increase the chances of success. The previous colonization point near Moorestown, New Jersey, was discarded, as it had proved too wet, and the development of soil insects there appeared unduly retarded. Three locations, in soils of different types, but all well drained and heavily infested with Japanese beetle grubs, were selected, at Philmont, in Pennsylvania, and at Merchantville and Berlin, in New Jersey. At these three locations, 16,660 parasitized grubs and 4,107 field collected females were liberated. Subsequent diggings indicated that parasites released with host grubs came through to the cocoon stage, and that released females actually attacked grubs in the field and deposited eggs upon them.

Tiphia No. 1851. Work has been continued with this red-legged species from southern Japan. Before liberations were made this year, scouting was done for possible adult recovery, with negative results, although eggs were found last year on grubs in the field shortly after mated females had been released. Further releasements were made at Merchantville, New Jersey, and consisted of 4,700 grubs bearing the eggs of the parasite, which were placed under the sod, and of 100 mated females. The material was obtained from 1,760 cocoons received in December, 1926, from which 219 males and 233 females emerged. Mating and propagation were quite successful, and large numbers of parasitized grubs were obtained. This is one of the few species of *Tiphia* which we have as yet been able to handle in the cocoon stage with a moderate degree of success.

Tiphia No. 2049. This small, delicate, Indian species has been imported for two years. Up to date, not enough individuals have been obtained for colonization, or even for a detailed study. All the material which was carried through its second winter in 1926–1927 died during

TABLE 1. YEARLY TOTALS OF LIVING PARASITES RECEIVED AND OF THOSE LIBERATED[5]

Name of Parasite	1920		1921		1922		1923		1924		1925		1926		1927	
	Rec.	Lib.	Rec.	Lib.	Rec.	Lib.	Rec.	Lib.	Rec.	Lib.	Rec.	Lib.	Rec.	Lib.	Rec.	Lib.
Centeter cinerea			101p	0	156,220p	700a	50,000p	6,557a	20,500p	2,052a	0	2,180a	0	0	142,000p	0
Ochromeigenia ormioides							194m	0	177m	177a	740m	228a	743m	743a	731m	731a
Eutrixopsis javana							210p	190a	0	0	0	0	0	0	0	0
Prosena siberita					8,120m	0	1,238m	83a	6,370m	4,975a	1,693m	1,609a	1,287m	905a	2,424m	1,888a
Dexia ventralis											49m	0	2,936m	1,545a	4,484m	2,184a
Tiphia popilliavora																
Japanese strain			360c	3f	2,830c	45f	0	15f	0	0	43f	43f	22f	0	0	0
Chinese strain											4,557c	0	7,899c	0	3,160c	232f
Korean strain											35c	0	0	0	600c	45f
Tiphia vernalis									3,664c	0	5,090c 42m	30a 0	4,611c 454f	0 4,301e	2,624c 5,211f	0 16,660e 4,107f 47a
Tiphia No. 1851									89c	0	953c	0	111f	72f	1,760c	100f 4,700e
Tiphia No. 2049											4,929c	0	5,870c	0	20,363c	0
Tiphia No. 114													118f	89e		
Tiphia No. 2036													367c	0	2,256c	0
Campsomeris annulata							4c	0	0	0	1,198c 2,162a	0 2,257a	380c 2,271a	20c 1,748a	*	
Scolia manilae					9,854f	8,003f	3,399f	2,910f								
Craspedonotus tibialis	700a	0	6,069a	0	*											
Totals	700	0	6,530	3	177,024	8,748	55,045	9,755	30,800	7,204	21,491	6,347	27,069	9,423	185,613	30,694

[5] Explanation of symbols. (*) importations discontinued. (a) adults of both sexes. (c) cocoons. (e) ~~eggs deposited on the host~~ parasitized grubs. (f) mated females. (m) larvae, usually within body of host. (p) puparia. The totals are in many cases approximations, based on a preliminary examination at time of arrival, and are often much less than the totals shipped.

TABLE 2. SOURCES, TOTAL NUMBER OF INDIVIDUALS RECEIVED ALIVE, TOTAL NUMBER LIBERATED, THE YEARS RECEIVED AND LIBERATED, AND THE PRESENT STATUS OF THE PRINCIPAL SPECIES AND STRAINS INTRODUCED[6]

Name of Parasite	Imported from	Total number Received	Total number Liberated	Years When Received	Years When Liberated	rec.	REC.	EST.	Present Status
Centeter cinerea	Japan	368,821	11,489	'21–'24, '27	'22–'25	'22	'23	'23	EST.
Ochromeigenia ormioides	Japan	2,585	1,879	'23–'27	'24–'27				no rec.
Eutrixopsis javana	Japan	210	190	'23	'23				no rec.
Prosena siberita	Japan	21,132	9,460	'22–'27	'23–'27	'27	'27		REC.
Dexia ventralis	Korea	7,469	3,729	'25–'27	'26, '27	'27	'27		REC.
Tiphia popilliavora, Japanese strain	Japan	3,255	106	'21, '22, '25, '26	'21–'23, '25	'26	'26	'27	EST.
Tiphia popilliavora, Chinese strain	China	15,616	232	'25–'27	'27				——
Tiphia popilliavora, Korean strain	Korea	635	45	'25, '27	'27				——
Tiphia vernalis	Korea	21,696	25,145	'24–'27	'25–'27	'26			rec.
Tiphia No. 1851	Japan	2,913	4,872	'24–'27	'26–'27	'26			rec.
Tiphia No. 2049	India	31,162	0	'25–'27	——				——
Tiphia No. 114	China	118	89	'26	'26				no rec.
Tiphia No. 2036	India	2,623	0	'26, '27	——				——
Campsomeris annulata	Japan, Korea, China	6,015	4,025	'23, '25, '26	'25, '26				no rec.
Scolia manilae	Hawaiian Is.	13,253	10,913	'22, '23	'22, '23				no rec.
Craspedonotus tibialis	Japan	6,769	0	'20, '21	——				——
Totals		504,272	72,174						

[6] The numbers under "Totals received alive" are estimates, based on examinations at time of arrival. Explanations of the symbols: '22–'25 signifies the years 1922 to 1925 inclusive; (EST.), established; (no rec.), no recovery; (rec.), recovery of a stage different from the one liberated; (REC.), recovery after at least one full generation in the field.

the past summer, without appreciable emergence. In addition, 18,600 cocoons were received during the early part of 1927, but, like those of the previous year, they passed into the second winter without emergence.

Tiphia No. 114. No recovery has been made from the 1926 colonization of this spring-emerging species from China. No further material has been received, owing to the curtailment of work in China.

Tiphia No. 2036. From a shipment consisting of 1,823 reared cocoons and of 420 field-collected cocoons of this Indian spring-emerging species, which was received at Riverton in October, 1926, no adults emerged. Another shipment of cocoons arrived this fall, in which a considerable percentage was emerging prematurely. The 55 living females obtained were placed with grubs of the Japanese beetle, but failed to oviposit. The 2,198 unemerged and, apparently, healthy cocoons, are being carried to their normal emergence period in the early spring.

In addition to the work of receiving, handling, and liberating imported parasites, several consignments have been forwarded from the New Jersey station to the substation at Westbury, Long Island, for trial against the Asiatic beetle, *Anomala orientalis*, and against *Aserica castanea*, of which there are infestations at that point. The principal shipments made for this purpose were of 387 adult *Tiphia vernalis* and of 1,140 puparia of *Dexia ventralis*, from our receipts from Korea, and of 125 female *Tiphia popilliavora* collected at Riverton for subcolonization.

REVIEW OF THE WORK ACCOMPLISHED

Sixteen species and strains of parasitic and predacious insects (Table 1) have been imported in a large way since 1920. Three of these have been dropped, as being of no value against the Japanese beetle. Work was done with twelve during the past season, ten being received and seven released. The number of species and strains handled (Fig. 55) have gradually increased. They reached a high point in 1926, with a total of 11 received and 7 liberated, and decreased only slightly during the past season. The total number of individuals received alive (Table 2), based in part on estimates following examination made at arrival, is slightly over 504,000, and the number actually liberated is 72,174. These numbers seem rather low when compared with some of the other parasite introduction projects, but it should be remembered that most of the parasites of the Japanese beetle are confined to the soil throughout most of their life cycle, which greatly increases the labor of handling, for each unit obtained. The number of individuals released (Fig. 55), which, for several years past, has varied between 6,000 and 10,000, made a great jump to 30,694 during the past season. The record of two establishments, two additional species recovered after at least a full generation in the field, and two others recovered in a different stage from the one released, is a notable advance from one establishment and no recoveries recorded in 1925. The totals of individuals (Table 2) indicate that the largest liberations have been of *Tiphia vernalis*, *Centeter cinerea*, and *Scolia manilae*, in the order named. Rated as the largest importation, in respect to numbers received alive, *Centeter* exceeds all others combined, with a total of over 360,000. In the case of *Tiphia vernalis* and *Tiphia* No. 1851, the number of individuals available for releasement has been multiplied by using the imported females for the production of eggs, allowing more to be liberated than the total number received. Improvements in methods of insectary propagation have been made this season with other species, notably with *Dexia ventralis*

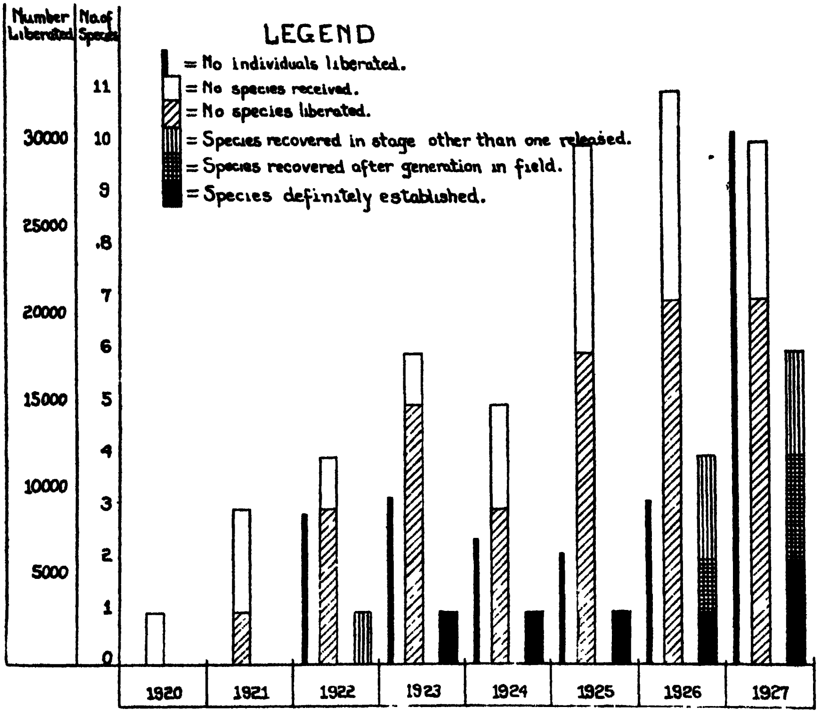

FIG. 55.—Showing the yearly totals from 1920 to 1927 of the number of parasites liberated, the number of species received, liberated, recovered and established.

and with *Prosena siberita*, the final results of which do not appear in this report. In a number of cases, as with *Centeter* and with the two Indian species of *Tiphia*, large numbers, which were received in resting stages, will be held for emergence until next season, and will not be recorded among the liberations until then.

OBSERVATIONS ON THE SNOUT-BEETLE, *EVOTUS NASO* LEC., ON APPLE TREES AT YAKIMA, WASHINGTON

By M. A. Yothers, *Associate Entomologist, Deciduous Fruit Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

The species is recorded as feeding on apple buds for the first time. There are observation on the feeding habits, oviposition and life history.

With the exception of the discussion of it by Chase,[1] there seems to be no reference to this curculionid (fig. 56) in the literature of economic entomology. Having had an opportunity for making certain observations, therefore, the writer presents the following.

When Chase made his observations on this weevil, it was supposed that it was a native feeder on the sage (*Artemisia* spp.) along with a number of other curculionids, some of which were reported upon by the writer[2] as feeding upon the buds of young fruit trees in the State of Washington. It was, therefore, somewhat surprising to find considerable numbers of this species on three-year-old apple trees set out in an old orchard well within an old orchard district. Mr. E. J. Newcomer and the writer found considerable numbers of these weevils in the C. O. Adams Orchard, one-half mile south of the town of Yakima, Wash., in late April and early May, 1925.

At the time the bud weevils were first discovered, April 25, the apple leaves were well out, and it was not possible to tell how much feeding had taken place upon the leaf buds, but occasional feeding punctures were observed on the leaves, indicating that the weevils had been eating there also. At 11 to 12 o'clock A. M., nearly all of the weevils were in pairs and in the act of copulation. Only very rarely was an unmated individual observed. They were sitting in pairs on the leaves, the leaf-petioles, the twigs, and within the half-opened young leaves. When disturbed, they fell quickly to the ground, where, owing to their color, they were lost to sight. On the ground under the trees a few dead individuals were found. Although the sex of these was not determined, it is probable that they were males, since male specimens kept for observation in the laboratory soon died, whereas females lived much longer.

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[1] Chase, G. M. The Snout Beetle or Bud Weevil. *In* Wash. State Hort. Assoc. Rpt. 7th, p. 91, 1911.

[2] Yothers, M. A. Bud-weevils and Other Bud Eating Insects of Washington. Wash. State Exp. Sta. Bul. 124, Feb., 1916.

In one test, four males, confined alone in a glass dish and given apple, peach, and pear leaves for food, ate of each during a period of two days, but were all dead at the end of 6 days.

Another lot of four pairs was placed, on April 30, in a glass dish with apple, peach, and pear leaves for food. On May 2, the weevils had eaten slightly of each kind of foliage. In the folded edges of the leaves they had deposited four groups of eggs containing the following numbers: 12, 13, 18, 26. These eggs were white, translucent, cylindrical, with obtuse ends. The egg-masses were deposited within the folds made of the edges of the leaves folded over, and were sealed with a sticky substance.

During the period of observation of the above four pairs, April 30 to May 2, they were observed many times in the position and several times in the act of copulation.

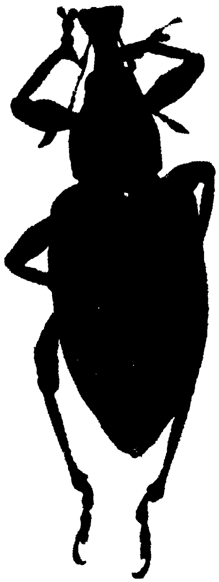

FIG. 56.—*Evotus naso* Lec., a curculionid sometimes found eating the buds of young apple trees in the state of Washington. Magnified about 6 times.

On May 2, this lot of four pairs of weevils was transferred from the small glass dish to a flowerpot-chimney cage, the pot containing slightly moist earth. In this cage the weevils were confined during the remainder of the observations. The record of activities between May 2 and May 11 was lost, and it is therefore impossible to state what foods were eaten, and what eggs were deposited during that period. On May 11, however, three beetles were still alive and active—two females and one male. The record of these is given in Table 1.

While the information is meager and incomplete, it seems that under artificial conditions, at least, this weevil will eat leaves of apple, peach, pear, poplar, locust, and lamb's-quarters, but that it did not appear inclined to eat dandelion, violet, or sunflower leaves. Further tests

TABLE 1. FEEDING AND OVIPOSITION RECORD OF TWO FEMALES AND ONE MALE *Evotus naso* LEC., CONFINED IN FLOWERPOT-LANTERN-CHIMNEY CAGES, YAKIMA, WASH., 1925

Date	Food Supplied (leaves)	Food Eaten	Eggs Deposited	Remarks
May 11	apple, dandelion	apple		
12	apple, dandelion	apple		
13	poplar, locust, lambsquarters	each		
14	apple, peach, hop	apple		
15	peach	peach		
16	sunflower	none	10, 18	In coitu
17	mustard, violet	none	10	
18	apple, poplar	both		
19	apple	apple		
20	apple, pear	both		
21	poplar	poplar		
22	peach	peach	group	
23	sunflower	none		
24	pear	pear		
25	apple	apple	group	
26	pear	pear		
27	apple, pear	apple	group	
28	apple, peach, pear	each		Actively feeding at 1 P. M.
29	apple, peach, pear	each		
30	apple, peach, pear	each		
June 1	apple, pear	both	group	
2	apple, poplar, violet	poplar		
3	apple, poplar, violet	apple, poplar		
4	apple, pear	pear		
5	apple, pear	pear		
6	apple, pear	pear	group	
9	apple, pear	pear	group	
10	apple, pear	both		
June 11	apple, pear	pear		
12	apple, peach, pear	each		
13	apple, pear	both		
15	apple	apple		Ate 1½ inch sq.
16	apple	apple		
17	apple	apple		
18	apple, peach, pear	none	group	
19	apple, peach, pear	peach, pear		
20	apple, peach	both		
22	apple, peach	both	group	
24	apple, pear	both		
25	apple, peach	peach	group	
26	apple, peach	peach	group	
27	apple, peach	none		
29	apple, peach	peach		
30	apple, pear	none		One ♀ died
July 1	apple, peach, pear	none		
2	apple, peach, pear	peach		
3	apple, peach	none	group	
6	apple, peach, pear	none		
7	apple, peach, pear	none		
8	apple, peach, pear			
9	apple, peach, pear	none		
10	strawberry	none		
11	peach, pear	none		
15	apple, peach, pear	none		Last ♀ died

might show that these last-named might also be food plants, or that some of those plants fed upon in cages might prove unattractive to the weevils in nature.

It is not known how many eggs are laid on the average by this weevil, but evidently each female deposits several groups, each group containing from 10 to 25 eggs. Two females (Table 1) deposited at least 13 such groups, three of which contained an average of 12⅔ eggs. Four other groups averaged 17¼ eggs, with a minimum of 12 and a maximum of 26. It is probable that an average of about 100 eggs may be laid per female.

Observations on deposition, hatching, and incubation of eggs are shown in Table 2.

TABLE 2. DEPOSITION, INCUBATION AND HATCHING RECORD OF EGGS OF THE CURCULIONID *Evotus naso* LEC., YAKIMA, WASH., 1925.

Number of Eggs	Date Eggs Deposited	Date Eggs Hatched	Number of Eggs Hatched	Number of Days of Incubation
69	May 2	May 28*	Many	26 plus
28	May 16	June 11	7	26
		June 12	10	27
		June 13	7	28
		June 14	3	29
		June 15	1	30
10	May 17	June 15	5	29
?	May 28	June 17	5	26
		June 18	2	27
?	May 26	———	-	—
?	May 28	———	-	—
?	June 1	June 29	2	28
?	June 6	———	-	—
?	June 9	July 1*	several	22 plus
		July 3	2	24
?	June 18	———	-	—
14	June 22	July 10	2	18
		July 11	2	19
		July 14	2	22
?	June 25	———	-	—
?	July 6	———	-	—

*Larvae hatched out and dead.

It is not known when oviposition begins in the spring, but it is probably in late April or early May. Females under observation from April 30 to May 2 deposited eggs within leaves in cages, and it is therefore reasonable to suppose that this species was depositing eggs in the orchard at the same time. Whether they deposit their eggs, under normal conditions in the orchard, within folds of the leaves, is not known, but no such egg-masses have been seen on the trees. Apparently the deposition period extends over a rather long period of time—at least from late April to early July. The incubation period for eggs is from 18 to 30 days, with an average of about three to four weeks.

One female lived at least 75 days, and another at least 60 days. How long these had lived as adults before observation is unknown, but it is probable that they had been adult for some time.

Apparently the weevils cease to eat several days before they die (Table 1).

Attempts to rear the young larvae in small tin pill boxes, filled with fibrous roots and slightly moist earth, failed, and nothing further was learned of the growth and development of the larvae.

ARE CODLING MOTHS ATTRACTED TO LIGHTS?

By M. A. YOTHERS, *Associate Entomologist, U. S. Bureau of Entomology, Yakima, Wash.*

ABSTRACT

For many years entomologists have agreed that the codling moth, *Carpocapsa pomonella* L., is not attracted to lights. A test, in 1926, with light in a closed storage room, in which codling moths were emerging, however, showed that they were readily attracted to a small light. A test in an orchard subsequently showed them only slightly attracted to a light trap in a tree top. Another test, in 1927, which was much more comprehensive, showed them readily attracted in large numbers to varying intensities of light in light traps operated under normal orchard conditions.

Since the publication, in 1902, of Slingerland's[1] report of experiments with trap lanterns for capturing injurious insects, entomologists generally have agreed with his conclusion that the codling moth, *Carpocapsa pomonella* L. is not attracted to lights. With the exception of this test, however, little has been done upon this particular phase of codling-moth control. Nevertheless, light traps of various kinds have been offered to the public from time to time, and the claim has been made for them by the manufacturers that they were effective in attracting and capturing the codling moth as well as other insects. It has been customary for entomologists to discountenance these claims without investigation, assuming that the conclusions reached in 1902 could be accepted as final. A recent revival of interest among entomologists and the laity in the various supplementary measures for codling-moth control has led the writer to make tests of a number of these, including the use of lights.

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[1] Slingerland, M. V. Trap Lanterns or "Moth Catchers." Cornell University Agr. Exp. Sta. Bul. 202. 1902.

TESTS WITH LIGHTS AND BAIT IN ATTRACTING CODLING MOTHS IN A FRUIT STORAGE ROOM

On June 10, 1926, when the writer entered a dark, tightly-closed fruit storage room in which several thousand apple lug boxes were stored and switched on the lights, he noticed many codling moths fluttering about them. This suggested to him the idea that possibly, under these conditions, the moths might be attracted to lights. It was learned that the boxes had been used the previous season and were to be stored here until midsummer, when they would be used again, after the moths had emerged and died. The temperature of this room was much below that outside, as was shown by a thermograph placed in it later on. The low temperature had retarded moth emergence, but just how much could not be determined, since this was the first observation in the storeroom. Moth emergence began in the orchard about April 16–20, and was practically over by this date (June 10), but was not completed in this storeroom until July 4.

On June 10 six 1-quart fruit jars containing fresh apple-ferment bait[2] were placed upon the tops of stacks of boxes in the storeroom, at varying distances (from 5 to 50 feet) from a single 25-watt carbon electric light. In addition, a 6-gallon can containing about 3 gallons of the same bait was placed about 10 feet from the light. Aside from this light the storeroom was in continual darkness. Three days later the jar 5 feet from the light had 4 females and 1 male moth and the large can had the same, whereas all other jars at greater distances from the light had caught none. This test indicated that in the storeroom the light had greater attraction to the moths than the bait. (Table 1.)

During the next 3-day period the only change made in the test was to place the large can directly underneath the light and about 1 foot below it. Some time during the period the light burned out, so it was not known how long the moths were subjected to it. The jar 5 feet from the light had attracted 3 females and 1 male, the one 10 feet distant had attracted a single female, and all the other jars were without moths; but the large can under the light had attracted 733 moths, of which 58 per cent. were females. This great number of moths attracted to a single small light during an unknown part of a 3-day period was, to the writer, rather astonishing, inasmuch as the moths were not supposed to be attracted to light at all. At the next examination, 23 hours later, the jar 5 feet from the light had 3 females and 1 male and all others had none, but the can under the light had attracted 1,100 moths, of which 60 per cent. were females.

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[2] Apple ferment is one of the baits used in attracting codling moths. It is prepared by grinding 1 pound of apples and then cooking them in 1 gallon of water. After this has cooled one-half pound of brown sugar and one-half ounce (1 cake) of fresh yeast are added to it.

During the next 24 hours the following test was made: In addition to the jars and the large can under the light, a large can containing water only was placed under another light about 40 feet distant from the first. In this test the bait can caught 217 moths, of which 61 per cent. were females, and the water can caught 193, of which nearly 65 per cent. were females. This indicated that it was the light and not the bait that attracted the moths, and that they fell into the water and the bait in about equal numbers more or less accidentally, from exhaustion or otherwise, while they were about the lights.

After this test the use of the water can and the light with it was discontinued. The two large cans had together attracted 410 moths on the night of June 17, whereas only one of them had attracted 1,100 moths the night before, which indicated that the peak of moth emergence, or at least of moth attraction, had been reached. Thereafter daily captures became less and less until July 4, when the last moths were captured.

In these tests a total of 4,006 moths were captured, of which 59.16 per cent. were females. Granted that both sexes are about equally attracted to light, this percentage would give about the normal proportion of the sexes, because none of either had had an opportunity to escape. This proportion of the sexes also agrees with the proportion captured in trap baits in orchards. Of 18,448 moths captured in bait traps in the years 1923, 1925, and 1926, 57.34 per cent. were females.

Of course the unusual and abnormal conditions under which these tests were conducted justified the drawing of no conclusion regarding the attractive value of such a light in an orchard, under normal conditions; tests were therefore undertaken to determine this point. It is well known that the codling moth flies readily to windows when it is confined within a room, and remains there endeavoring to escape until it dies. In so far as this test is concerned, it might be that this endeavor to escape is the only significance of the attraction to the light.

TEST IN 1926 WITH AN ELECTRIC-LIGHT TRAP IN AN ORCHARD (TABLE 2)

On July 14, 1926, a device consisting of an electric light surrounded by a framework of electrically charged wires was hung in a tree about 10 feet from the ground, in an orchard known to be pretty well infested with codling moths. Underneath this electric trap a large tub was suspended to catch as they fell toward the ground any insects killed by the machine. The light used in the trap was of 60-watt intensity. This trap, operated during the period July 14–19, attracted and killed many insects of several kinds, including about three dozen Chrysopas, but only two codling moths, although plenty of moths must have been present, as indicated by the contents of bait traps placed elsewhere in the orchard.

On July 19 the light was supplemented by 4 gallons of apple-ferment bait placed in the tub beneath the light. This attracted 27 moths during the three nights, indicating that the bait and light were more attractive than the light trap alone. During the next three nights the bait tub, operated without the light trap, captured 44 moths, indicating that the bait alone was more attractive than the light alone or the bait and light together. Further tests, during the next five nights, with the light trap and the tub with water resulted in the capture of 15 moths—far less than were captured in the bait for a 3-day period.

These tests showed, however, that some moths may be attracted to lights even out in the orchard.

TESTS IN 1927 WITH TWO TYPES OF ELECTRIC-LIGHT TRAPS (TABLE 3)

On August 2, 1927, two electric-light traps were installed in two small blocks of badly infested fruit trees. One trap was the electric device discussed previously, but in this case it was suspended on a wire midway between the tops of two trees, the tub for catching the killed insects being suspended between two poles just under the trap. The other trap consisted of a metallic pan about 2 feet in diameter, from which arose four uprights supporting a metallic roof from which an electric light was suspended. The trap was merely a receptacle for oil or other material used to catch the insects attracted to the light, and a support for a light. Both of these traps are patented insect destroyers. They were operated over a period of 35 days, red, blue, and clear lights of varying intensities from 10 watts to 200 watts being used, these at times being supplemented with molasses-ferment bait.[3] The two traps are not meant to be comparable, although each was situated in its own small block of about a dozen badly infested trees, and each was located the same distance from a larger and badly infested orchard.

Although the results of this test indicate a number of interesting points, the main thing is that considerable numbers of codling moths were attracted to these lights out in the orchard under normal conditions of severe infestation, which is contrary to former experience along this line. A total of 802 codling moths were captured in these two traps, practically all by the lights alone, as the addition of baits late in the season did not increase the catch.

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[3] Molasses ferment bait consists of 1 part of molasses to 10 or veen 30 parts of water to which is added about one-half ounce (1 cake) of fresh yeast.

TABLE 1. NUMBER OF CODLING MOTHS CAPTURED AT LIGHT AND BAIT TRAP IN FRUIT STORAGE ROOM, YAKIMA, WASH., 1926.

Date	Trap	Time Exposed *Days*	Number of Moths Captured Female	Male	Total No. of Moths
June 13	Bait 10 ft. from light	3	3	1	4
June 16	Bait under light*	3	425	308	733
June 17	do	1	650	450	1,100
June 18	do	1	133	84	217**
	Light with water below	1	125	68	193**
June 19	Bait under light	1	165	114	279
June 20	do	1	65	72	137***
June 21	do	1	148	95	243
June 22	do	1	143	128	271
June 23	do	1	157	122	279
June 24	do	1	114	72	186
June 25	do	1	82	40	122
June 26	do	1	63	36	99
June 27	do	1	37	14	51
June 28	do	1	20	14	34
June 29	do	1	10	4	14
June 30	do	1	11	5	16
July 1	do	1	7	4	11
July 2	do	1	9	3	12
July 3	do	1	2	1	3
July 4	do	1	1	1	2
July 5	do	1	0	0	0
Total			2,370	1,636	4,006

*Six-gallon can containing apple-ferment bait (described elsewhere) placed 1 foot below the 25-watt carbon electric light.

**Two cans operated simultaneously, one containing water, the other apple-ferment bait. Both placed under light of same intensity, and about 40 feet apart.

***Two factors tended to reduce this number caught: Too many large particles of apple covering surface of bait, and lower temperature.

Probably the number of moths captured does not vary uniformly in proportion to the intensity of the light, but there are instances which point in that direction, as in the case of the oil-and-light trap on August 5, when the capture jumped from 5 moths caught with a 10-watt light to 50 caught with a 60-watt light; and again on August 17, when 76 moths were caught with a 200-watt light and only 4 the night before with a 100-watt light. Red or blue lights of 10-watt capacity do not appear particularly different in attractive capacity from the clear lights of the same power. It is apparent that the catches are not entirely accidental, since no moths were caught on any night when the lights were off, as on August 8 and 25 in the case of the oil-and-light trap.

When the temperature falls below a certain point codling moths apparently react to lights in the same manner as they do to baits. This is shown very significantly by the low captures on August 12, 13, and 14, when the mean temperature dropped from around 78°F. to about 56°F. (Table 3.) Captures in bait traps at this same time dropped from around 1,000 moths to 11 moths on the 13th.

The capture by the two light traps averaged together 22.92 moths per day for the whole period they were in operation. During the period (August 3 to 25) when the moths were abundant and active, as shown by bait traps near by, the moths captured by the two traps averaged 32.68 per day.

In conclusion it may be stated that, contrary to long-established belief, the codling moth can be readily attracted to lights under normal orchard conditions. These tests made do not prove, however, that such traps as were tried are of any considerable control value.

TABLE 2. NUMBER OF CODLING MOTHS CAPTURED AT AN ELECTRIC LIGHT ELECTROCUTOR TRAP, YAKIMA, WASH., 1926.

Date	Trap or otherwise	Time of Exposure *Hours*	Number of Moths Captured
July 15	Trap alone	24	0
July 16	do	24	2
July 17	do	24	0
July 19	do	48	0
July 22	Trap with bait below	72	27
July 25	Bait alone	72	44
July 28	Trap with bait below	72	17*
July 31	Bait alone	72	12
Aug. 3	Trap with water below	72	5
Aug. 9	do	114	10

*Light had burned only 2 nights. Moths appeared to be recently caught, as if after light had burned out.

TABLE 3. NUMBER OF CODLING MOTHS CAPTURED AT LIGHT TRAPS, YAKIMA, WASH., 1927.

	Electric Light Electrocutor		Electric Light with Pan		
Date	Number of Light Watts	Number of Moths Captured	Number of Light Watts	Number of Moths Captured	Mean Daily Temp. °F.
Aug. 3	60	25	10	7	76
4	60	20	10	5	78.5
5	10	12	60	50	78
6	10	22	60	23	79
7	10	43	60	16	76
8	100	23	Off	0	77.5
9	100	30	60	20	78
10	60	25	100	17	76.5
11	200	34	100	5	71
12	200		100		56.5
13	200	2	100	1	63.5
14	200	10	100	5	72.5
15	200	50	100	6	78.5
16	200	17	100	4	73.5
17	200	30	200	76	77.5
18	200	33	200	60	73.5
19	Red 10	0	Blue 10	0	76
20	Red 10	8	Blue 10	3	74.5
21	Blue 10	3	Clear 10	0	72.5
22	Blue 10		Clear 10		73
23	Blue 10	7	Clear 10	4	74.5
24	Blue 10*	7	Clear 10	12	68.5
25	Blue 10	4	Off	0	63
26	200	4	200	9	63
27	200		200		69
28	200	5	200	7	63
29	200		200		58.5
30	200	1	200**	0	55.5
31	200	3	200	0	59.5
Sept. 1	200	10	200	2	63
2	200	1	200	1	64
3	200†	0	200	2	62.5
4	200	5	200	3	62.5
5	200	11	200	9	61
6	200	1	200	9	58
7	200	7	200	0	56.5
8	Off	0	Off	0	54
Total		446		336	
Grand Total				802	

*Up to this time the tub beneath the trap was dry. Molasses bait was put in.

**Up until this time the tub beneath the light contained clear oil. Molasses bait was put in.

†Renewed molasses bait with new.

SOME OBSERVATIONS ON THE NUMBER OF LARVAL INSTARS OF THE ORIENTAL PEACH MOTH, *LASPEYRESIA MOLESTA* BUSCK

By ALVAH PETERSON, *Senior Entomologist*, and G. J. HAEUSSLER, *Assistant Entomologist, Deciduous Fruit Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

By applying Dyar's ideas that the width of the head-capsule of a lepidopterous larva is more or less constant for any instar of a given species and that successive larval instars of a given species show a more or less regular geometric progression in the growth of the head-capsules, oriental peach-moth larvae are found to have four or five instars.

The number of larval instars produced is correlated with the rate of larval growth. As a rule rapid growth produces four instars and slow growth five instars.

Rapidity of larval growth is dependent upon at least two factors, temperature and food. High summer temperatures produce rapid growth while low temperatures, such as occur in the spring and fall, produce slow growth. Larvae develop somewhat faster in peaches than in apples under insectary conditions.

The rate of development of individual larvae in a given food varies considerably.

INTRODUCTION

During 1926 it was learned that oriental peach moth larvae go through four or five instars before they are full grown. The facts showed clearly that larvae hatching in June had four instars while larvae hatching late in September had five instars. This difference aroused our curiosity, consequently, in 1927 the following observations were made to see if we could determine the factors correlated with this difference.

Throughout the season several lots of eggs taken from the different broods (each lot had 500 or more eggs of the same age) were allowed to hatch on apples and peaches, and the larvae entered the fruit. Figure 57 and Tables 1 and 2 show the brood from which the eggs came, the food the larvae were reared on, and the date when each lot was started. In 1926 daily cuttings were made of the fruit and ten to twenty larvae were removed, killed in hot water, and preserved in Kahle's fluid. The results of the tests in 1926 taught us that daily removal was unnecessary, consequently, in 1927 the interval between the cuttings was 48 to 72 hours or longer (see Table 2). The fruit was cut open and ten to twenty larvae were removed at each cutting. Cuttings were continued until the first full grown larva had emerged and spun a cocoon.

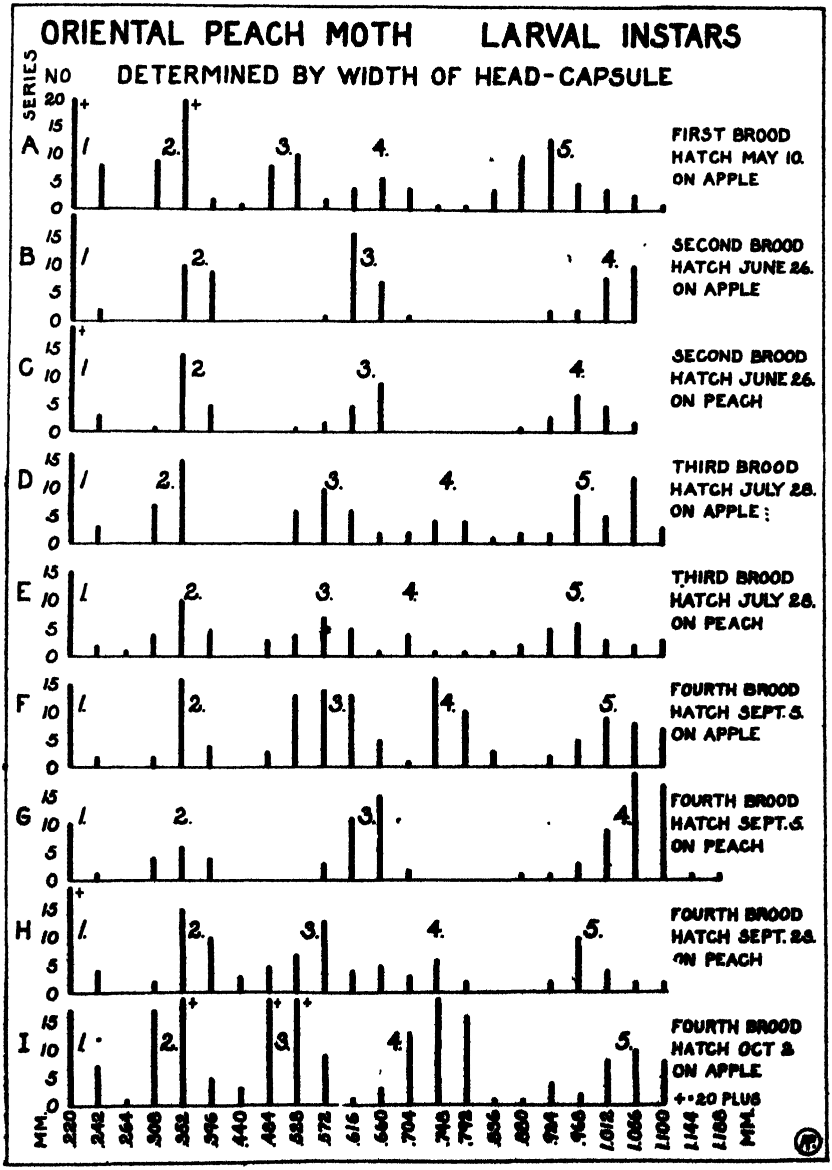

FIG. 57.—Graph showing grouping of oriental peach moth larvae according to width of head-capsules.

As a rule no larvae were removed from the fruit after this period, except in series G. The fruit containing the larvae was kept in cloth covered 6″ x 8″ glass jars in an open screened insectary and subjected to the normal outdoor temperatures.

OBSERVATIONS

Dyar[1] has shown that the width of the head-capsule of a lepidopterous larva is more or less constant for any instar of a given species. Also the successive larval instars of a given species show a more or less regular geometric progression in the growth of the head-capsules.

If we apply Dyar's ideas to the oriental peach moth the following facts are revealed. In Figure 57 the measurements of the widths of the head-capsules of larvae removed at regular intervals from fruit are not equally distributed between the minimum size (.220 mm.) and the maximum size (1.188 mm.) but fall into groups. In series B, C and G there are four distinct groups or, according to Dyar, four instars while in series A, F and I there are five distinct groups or instars and in series D, E and H there are indications of five groups or instars, the questionable groupings occurring between .440 mm. and .880 mm. If one assumes that the width of the head-capsule of a given instar is more or less constant then there are four or five instars in the development of an oriental peach moth larva.

Furthermore, according to Dyar, there should be a more or less regular geometric progression between the widths of the head-capsules of the several instars. Table 1 shows the growth ratio existing between the larval instars figured for the several broods reared on apples or peaches. In all cases it will be noted that the grand average ratio for larvae showing four instars is somewhere between .57 and .61 while with larvae showing five instars the grand average ratio is somewhere between .63 and .75. In the latter series there appears to be a slightly greater ratio between the later instars than with the early instars. The greater variation may also be due in part to the existence in some of the series (D, E and H) of larvae that had four instars. The ratios are ascertained by dividing the average measurement of a preceding instar with the average measurement of a following instar, i.e., .222 mm. (first instar) by .372 mm. (second instar) equals .59.

The ratio of .68 established by Dyar for the larvae of *Papilio thoas* which has five instars falls in between .63 and .75 which we have ascertained for oriental peach moth larvae having five instars. The variations in the successive ratios ascertained for oriental peach moth larvae showing either four or five instars are fairly constant and not great enough to indicate that a larval instar has been overlooked. This substantiates the belief that oriental peach moth larvae have four or five instars.

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[1] Dyar, H. G. 1890. "The number of molts of lepidopterous larvae." Psyche, Vol. 5, pp. 420–422.

The number of larval instars appears to be correlated with rate of development. If a larva develops rapidly as in series B, C and G (see Figure 58 and Table 2) when it took less than 14 days to obtain a high percentage of larvae with head-capsules measuring .924 mm. or larger, four instars occurred. If development is slow as in series A, F and I (see Figure 58 and Table 2) when it took 15 to 20 or more days to obtain a high percentage of larvae with head-capsules measuring .924 mm. or greater, five instars occurred.

In series D and E, third brood larvae, the development appears to be fairly rapid (Table 2), yet there is some indication of five instars, although this is not very definite. It is probable that most of the larvae in this series were four instar individuals.

Rapidity of larval growth is dependent upon at least two factors, temperature and food. We will not go into an extensive discussion of this subject at this time. Our life history studies show that high summer temperatures produce rapid growth and the average time for a larva to complete its development in peaches is approximately 12 days. Early or late season temperatures are lower, especially at night, and the larvae require 15 to 20 days or longer, in peaches, to become full grown.

Larvae develop faster in peaches than in apples under insectary conditions. During mid-season the larvae remain in the apples about two days longer than in the peaches. This difference is more pronounced late in the season at lower temperatures. The influence of the food on the development of the larva and the number of instars is well illustrated in series F and G in Figure 58 and Table 3. These series were started on the same date yet the time of development varied sufficiently to produce a distinct difference in the number of instars, four occurring among the larvae in the peaches and five occurring among the larvae in the apples.

Table 3 not only illustrates the decided difference in the rate of growth of larvae grown in apples and peaches but it also shows the great variation that occurs in the size of individuals on either fruit on a given date. Representatives of two or three instars may be found in the apples or peaches on certain dates even though all of the eggs hatched on the same day. This is particularly true about the time the first individuals of a lot go into their last instar.

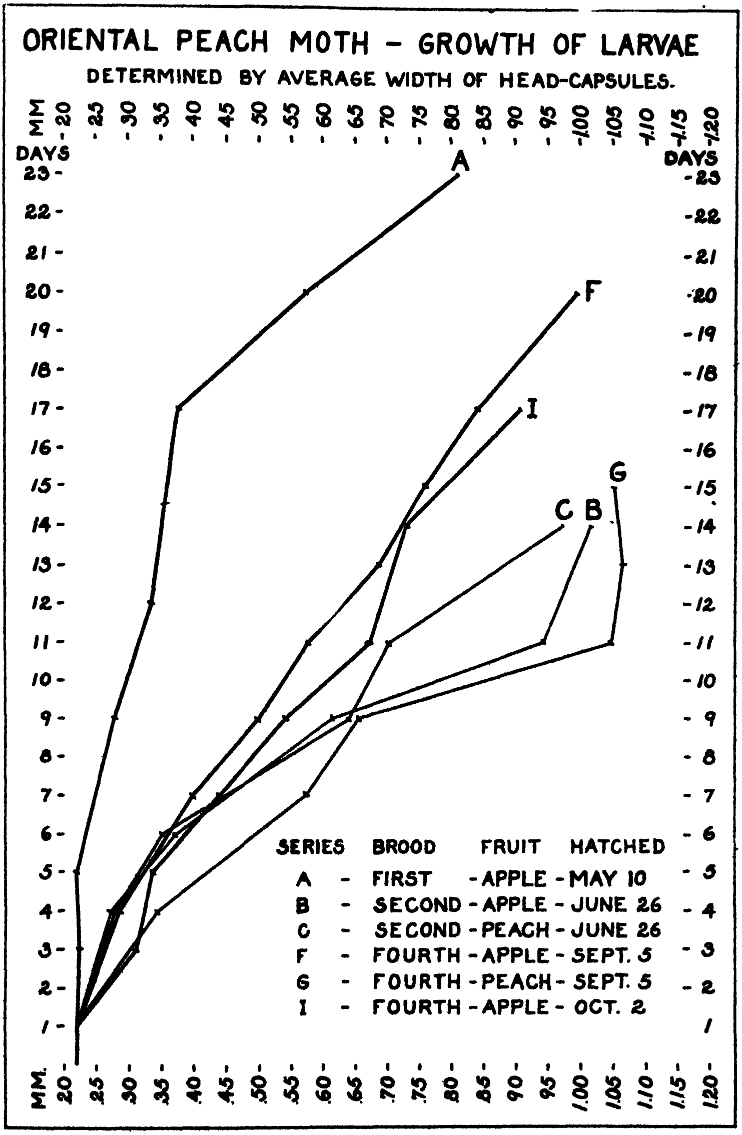

FIG. 58.—Graph showing growth of oriental peach moth larvae as determined by width of head-capsules.

CONCLUSIONS

If we assume that Dyar's idea on the possibility of ascertaining instars among lepidopterous larvae by measuring the width of the head-capsules is correct, then oriental peach moth larvae have four or five instars.

The average width of the head-capsules of oriental peach moth larvae having four instars approximates .222, .362, .633 and 1.033 mm. while that of five instar larvae approximates .222, .348, .546, .746 and .993. The average ratios of growth between the four instars are .61, .57 and .61 or approximately .59 and between the five instars are .63, .63, .73 and .75 or approximately .68. The number of instars produced is correlated with the rate of larval growth. As a rule rapid growth produces four instars and slow growth five instars.

Rapidity of larval growth is dependent upon at least two factors, temperature and food. High summer temperatures produce rapid growth while low temperatures such as occur in the spring and fall produce slow growth. Larvae develop somewhat faster in peaches than in apples under insectary conditions.

The rate of development of larvae in a given food varies considerably.

TABULAR DATA

Table 1 shows the average width in millimeters of the head-capsules of larvae of each instar. Twenty or more larvae were used to obtain each average. The table also shows the ratio of growth between the instars when four instars distinctly occur (B, C and G) and when five instars are indicated or distinctly occur (A, D, E, F, H and I). The determination of the number of instars and the limits of each instar was obtained from the information shown in Chart 1.

Table 2 shows the average width in millimeters of the head-capsules of oriental peach moth larvae of varying ages. Ten to twenty or more larvae were measured to determine each average. The brood, food and hatching dates are indicated.

Table 3 shows the difference in the rate of growth of larvae started on the same day (September 5) in peaches (series G) and in apples (series F) determined by measuring the width of the head-capsules. The number of larvae of each size for respective series at each age are shown. Note the decided difference in the size of the head-capsules of the larvae, particularly at the eleventh day and thereafter. All larvae in series G are in the last instar by the thirteenth day while in series F some of the larvae have not reached the last instar by the twentieth day. Also note the great variation in the sizes for both series at most ages, particularly after the seventh day.

TABLE 1. AVERAGE WIDTH OF HEAD-CAPSULES OF ORIENTAL PEACH MOTH LARVAE OF SEPARATE INSTARS AND RATIO OF GROWTH BETWEEN THE INSTARS

Series	Brood	Food	Hatched	First Instar	Ratio	Second Instar	Ratio	Third Instar	Ratio	Fourth Instar	Ratio	Fifth Instar
				mm.		*mm.*		*mm.*		*mm.*		*mm.*
B	Second	Apple	June 26	.222	.59	.372	.59	.630	.61	1.020	——	——
C	Second	Peach	June 26	.223	.61	.360	.57	.628	.64	.977	——	——
G	Fourth	Peach	Sept. 5	.221	.62	.352	.55	.638	.60	1.056	——	——
B, C, G	Combined grand average			.222	.61	.362	.57	.633	.61	1.033	——	——
A	First	Apple	May 22	.223	.64	.344	.67	.511	.75	.673	.72	.932
D	Third	Apple	July 28	.223	.65	.338	.58	.579	.75	.764	.75	1.007
E	Third	Peach	July 28	.222	.63	.349	.61	.565	.77	.731	.74	.982
F	Fourth	Apple	Sept. 5	.222	.62	.356	.61	.575	.72	.796	.77	1.030
H	Fourth	Peach	Sept. 23	.221	.59	.372	.68	.541	.75	.717	.72	.994
I	Fourth	Apple	Oct. 2	.226	.64	.340	.66	.515	.69	.746	.72	1.029
A, D, E, F, H, I	Combined grand average			.222	.63	.348	.63	.546	.73	.746	.75	.993

TABLE 2. AVERAGE WIDTH OF HEAD-CAPSULES OF ORIENTAL PEACH MOTH LARVAE OF SPECIFIED AGES

Series	Brood	Food	Hatched	Age of Larvae in Specified Days																	
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	17	20	23
				Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
A	First	Apple	May 22	.226	—	.224	—	.222	—	—	—	.277	—	—	.335	—	—	—	.376	.577	.812
B	Second	Apple	June 26	.224	—	—	.272	—	.372	—	—	.616	—	.944	—	—	1.016	—	—	—	—
C	Second	Peach	June 26	.223	—	—	.277	—	.365	—	—	.640	—	.699	—	—	.973	—	—	—	—
D	Third	Apple	July 28	.221	—	.288	—	.348	—	.509	—	.641	—	.854	—	1.029	—	—	—	—	—
E	Third	Peach	July 28	.224	—	.276	—	.376	—	.519	—	.619	—	.954	—	.963	—	—	—	—	—
F	Fourth	Apple	Sept. 5	.222	—	—	.284	—	—	.399	—	.498	—	.579	—	.688	—	.761	.840	.994	—
G	Fourth	Peach	Sept. 5	.222	—	—	.356	—	—	.574	—	.652	—	1.044	—	1.063	—	1.053	—	—	—
H	Fourth	Peach	Sept. 23	.221	.230	—	—	.222	—	—	.321	—	.531	—	.641	—	—	.957	—	—	—
I	Fourth	Apple	Oct. 2	.226	—	.316	—	.345	—	.440	—	.543	—	.673	—	—	.726	—	.907	—	—

TABLE 3. NUMBER OF ORIENTAL PEACH MOTH LARVAE OF EACH SIZE AS SPECIFIED AGES IN TWO SERIES
SERIES F ON APPLES, SERIES G ON PEACHES

Age of Larvae (days)	Series	Total Number of Larvae	Width of Head Capsules (in millimeters)																								Average Width (mm.)
			.220	.242	.264	.308	.352	.396	.440	.484	.528	.572	.616	.660	.704	.748	792	.836	.880	.924	.968	1.012	1.056	1.100	1.144	1.188	
1	F	9	8	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	—	–	.222
1	G	8	7	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	—	–	.222
4	F	12	5	1	–	1	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	—	–	.284
4	G	10	–	–	–	2	5	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	.356
7	F	14	–	–	–	–	8	4	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	.399
7	G	18	–	–	–	2	1	1	–	–	–	3	2	7	2	–	–	–	–	–	–	–	–	–	–	–	.574
9	F	17	–	–	–	2	3	–	–	1	3	5	3	–	–	–	–	–	–	–	–	–	–	–	–	–	.498
9	G	18	–	–	–	–	–	–	–	–	–	–	8	9	–	–	–	–	1	–	–	–	–	–	–	–	.652
11	F	18	–	–	–	–	–	–	–	2	3	5	6	2	–	–	–	–	–	–	–	–	–	–	–	–	.579
11	G	22	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	3	9	7	1	–	1.044
13	F	17	–	–	–	–	–	–	–	–	6	1	3	–	–	–	3	2	–	–	–	1	1	–	–	–	.688
13	G	12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	3	3	4	–	1	1.063
15	F	19	–	–	–	–	–	–	–	1	–	2	1	–	1	8	3	–	–	–	1	–	–	2	–	–	.761
15	G	20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	3	8	7	–	–	1.053
17	F	22	–	–	–	–	–	–	–	–	–	–	1	2	–	6	4	1	–	1	1	4	2	–	–	–	.840
20	F	25	–	–	–	–	–	–	–	–	–	1	–	–	–	2	–	–	–	1	4	6	5	5	1	–	.994

EXPLANATION OF CHARTS

Chart 1 shows the irregular distribution or grouping of the larvae using the width of the head-capsule in millimeters as a basis for measurement. The larvae were removed from the fruit at more or less regular intervals (see Table 2). Nine series of observations are shown, one or more series from each brood. The location of the perpendicular heavy lines shows the respective widths of the head-capsules as indicated across the bottom of the Chart while the length of each perpendicular heavy line represents the number of larvae of each measurement as indicated by the numerals at the left of each series.

Chart 2 shows the average rate of growth of larvae determined by the average width of the head-capsules of all larvae removed at more or less regular intervals. Ten to twenty or more larvae were measured to determine the average measurement at each age. Six series are shown, three of them, B, C and G, which are known to have four instars (see Chart 1), show rapid growth while the other three series, A, F and I, which are known to have five instars, show slow growth. Series D, E and H have been omitted from this Chart (see Table 2).

A COOPERATIVE ESTIMATE OF THE LOSS CAUSED BY THE SUGAR-CANE MOTH BORER

By T. E. HOLLOWAY and W. E. HALEY, *U. S. Bureau of Entomology*

ABSTRACT

An account is given of the method of estimating the loss caused by the sugar-cane moth borer (*Diatraea saccharalis*) to the Louisiana sugar crop, as followed by the Bureau of Entomology and the Bureau of Agricultural Economics, U. S. Department of Agriculture. The effect on the Louisiana sugar industry of the publication of the first joint estimate is also noted.

As far back as 1902 an attempt was made to indicate the loss to the Louisiana sugar crop caused by the sugar-cane moth borer (*Diatraea saccharalis* Fab.) In that year Stubbs and Morgan (1) stated that the owners of a Louisiana plantation had given them figures on plantation results for an average of eleven years during which the borer was absent as compared with an average of three years after the borer had invaded their property. "There was," the plantation owners state, "a falling off of 4.98 tons (of sugar cane) per acre and about 25 pounds of sugar per ton." In 1911 Barber (2) estimated a loss of 1,078 pounds of sucrose per acre in cases where all canes are bored, which is not very unusual. In 1919 Holloway and Loftin (3) accepted the former figures, and calculated an average annual loss for Louisiana at $7,287,000.

There is no evidence that these high estimates of damage created much excitement among those connected with the sugar industry. Perhaps the time was not ripe for such figures, and perhaps they were discounted as coming from persons who had no practical knowledge of the sugar industry, and whose estimates were therefore unreliable.

In 1923, L. L. Janes, of the Bureau of Agricultural Economics, U. S. Department of Agriculture, proposed to the writers that they cooperate with him in estimating the loss caused by the sugar-cane moth borer. The writers agreed, and it was arranged that the two estimates should be obtained by entirely separate investigations, each office using its own methods. Mr. Janes obtained his figures by means of questionnaires sent to the planters. Taking their replies and checking the answers for one year against those for the previous year, he obtained figures indicating the loss, both in percentages and in tons of sugar.

The writers based their estimate on personally conducted field examinations. Finding that an infestation in which every stalk was bored, or 100 per cent, meant a loss of about one-third of the crop, they regarded a 100 per cent infestation as a loss of 33.33 per cent. On this basis, then, a 50 per cent infestation would be a loss of 50 per cent of 33.33 per cent, or 16.66 per cent. A 10 per cent infestation would be a loss of 10 per cent of 33.33 per cent, or 3.33 per cent and so on.

When Mr. Janes and the writers had obtained their final figures for the crop of 1923, the two estimates were compared and it was found that they agreed in a surprising way. Since then, the same procedure has been followed year after year, and the result has always been an agreement within 1 or 2 per cent. Various details were taken into consideration, and a compromise figure was agreed on and published as the joint estimate. While the methods of estimating could, without doubt, be improved, yet it is believed that an estimate of loss is reached which for all practical purposes is correct.

The first joint estimate was published early in 1924. This showed that for 1923 there had been the high loss of 23 per cent of the possible tonnage of sugar, while for 1922 it was indicated that there had been a loss of 17 per cent. An average annual loss was taken to be 19 per cent. These figures were widely published in the sugar journals, and at last the time had come when such estimates were to be taken seriously. The fact that two bureaus of the U. S. Department of Agriculture had collaborated in the making of these estimates doubtless had much to do with their acceptance.

Before the first joint estimate was published, it was feared that the high loss shown might be taken as a basis for unfavorable criticism of agricultural institutions and officials, and this is exactly what happened. Experiment stations and the Department of Agriculture were denounced for allowing such high losses to continue. The Louisiana sugar industry was slowly being wiped out of existence by various causes, principally the mosaic disease, and it could ill afford to shoulder the terrific loss caused by the moth borer.

The net result of all this criticism was beneficial, however. The planters and experimental workers got together as never before, meetings were held, popular articles were written and published, appropriations were obtained, and more recently practically the entire acreage has been planted to new and improved disease-resistant varieties of sugar cane following the advice of the Department and the Louisiana Experiment Station.

The writers would not go so far as to say that the publication of the first joint estimate showing losses from the borer caused a revolution in the Louisiana sugar industry. On the contrary it was a case in which, owing to combined damage from disease and insects, either a revolution or extinction was imminent, and the cane planters chose the former. But the writers do believe that this first estimate was one of the important factors which contributed to this fortunate result.

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2. BARBER, T. C. Damage to sugar cane in Louisiana by the sugar-cane borer. U. S. Dept: Agr. Bur. Ent. Circ. 139. 12 p. 1911.
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Annotated Bibliography of Wireworm Control Methods.—The writer is compiling a bibliography of papers relating to the control of Wireworms (Elaterid larvae). This Bibliography, containing summaries of the important papers, will be issued in bulletin form when completed. All American and foreign Entomologists who have published papers on Wireworms and their control, are requested to send copies of these papers to the undersigned, in order to make the Bibliography as complete as possible and to facilitate compilation.

C. A. THOMAS, *Pennsylvania State College Laboratory,*
Bustleton, Philadelphia, Pa.

A NEW LEAF MINER INJURIOUS TO LARKSPUR (*PHYTOMYZA DELPHINIAE* FROST)

By GRACE H. GRISWOLD, *Cornell University*

ABSTRACT

Both the larvae and the adults of the larkspur leaf-miner (*Phytomyza delphiniae* Frost) injure the plant. The various stages of the insect are described and notes are given on its life history and habits. Two hymenopterous parasites have been reared from the pupae: *Cyrtogaster liqueatus* Ashm. and a new species of Opius. Control measures are briefly discussed.

In June 1927 the writer's attention was called to withered foliage on some plants of perennial larkspur (*Delphinium cultorum*) in the gardens of the Department of Floriculture at Cornell University. Examination showed that the injury was being caused by tiny white maggots which were mining in the leaves. Material was collected and eventually adult flies were reared. When specimens were sent to Dr. S. W. Frost he found them to be a new species which he has just described (1928: 77–78) as *Phytomyza delphiniae.*

INJURY

Injury to the plant is caused in two ways. Not only do the maggots mine in the leaves but the adult flies inflict considerable damage by their feeding punctures. The mine is of the blotch type. At first it appears as a puffed-up blister-like area, but when the larvae have made their exit the leaf tissue withers and turns brown. In many instances plants were found covered with leaves in which large areas were dead. There may be one mine in a leaf or there may be several in different sections of the same leaf. Where there are several in a single leaf they appear to have no connection whatever with each other. Usually a number of larvae feed together in the same mine. Two or three individuals may be in close proximity while others are scattered about the edges. Sometimes, however, the maggots are concentrated in the same area. In one instance ten larvae were found feeding side by side in a single mine.

As previously stated the adult flies cause considerable damage by their feeding punctures. The flies feed on the under surface of the leaves, gouging out small round holes which run through to the upper epidermis. The openings of these holes vary considerably in shape. They may be circular, oval, or irregular in outline. On the average they measure from 0.13 to 0.18 mm. in diameter. In one case 45 of these tiny holes were counted within an area of less than a square centimeter at the end of a leaf. The edges of these tiny holes turn brown and where a number of them are close together they coalesce so that an entire section of a leaf will die due to the feeding punctures of the adult flies.

LIFE HISTORY AND HABITS

The egg is pearly white in color and oval in outline. It is not quite twice as long as wide. Measurements of several eggs showed them to be about 0.32 mm. in length and 0.17 mm. in width. The egg is laid in a puncture which the adult fly makes with its mouthparts. It is embedded in this hole so tightly that only with the greatest care can it be removed.

When the larva hatches from the egg its position is such that it can at once begin to feed and start a mine. The shell evidently remains across the opening of the hole in which the egg was laid for the newly hatched larva appears to be protected by a thin membrane. When full grown the larva, which then measures about 3.5 mm. in length, leaves the mine through a small crescent-shaped slit. These slits appear on the under surface of the leaves and are about 2.5 mm. in length.

After the larva has left the mine pupation occurs. At first the puparium is dirty white but it gradually takes on a brownish tinge. Just before the adult emerges the puparium becomes dark brown, almost black. The puparia at first seem to stick to the leaves, but eventually some, at least, drop to the ground. When ready to emerge, the adult fly pushes out through one end of the puparium.

The lengths of the egg and larval stages have not yet been determined. During warm weather in midsummer the pupal stage was found to be about 16 days. In September it was somewhat longer, while in October it was prolonged to over a month. This insect passes through several generations a year. It attacks not only the summer larkspur plants but it also mines in the leaves of the second growth which develops in late summer and early fall. In 1927 larvae were found in mines as late as October 27th. It is probable that the insect overwinters as a pupa on the surface of the ground, though this has not yet been definitely determined.

NATURAL ENEMIES

Two species of hymenopterous parasites[1] were reared from the pupae of this fly:—nine males and thirteen females of *Cyrtogaster liqueatus* Ashm. and a single specimen of a new species of Opius.

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[1] Determined through the courtesy of A. B. Gahan of the U. S. Bureau of Entomology.

CONTROL

Of course the insect can be controlled by removing and burning all infested leaves before the larvae have left the mines. It is planned this coming summer, however, to try out various insecticides in an effort to find one that will reach the young larvae in their mines without injuring the foliage of the plant.

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HIBERNATION OF CHINCH BUGS IN SUDAN GRASS[1]

By HARRY R. BRYSON, *Kansas Agricultural Experiment Station*

ABSTRACT

An examination of 604 bunches of Sudan grass (*Sorghum vulgare sudanensis*), taken from various types of fields and covering a period of four years, showed a maximum of 540 bugs (*Blissus leucopterus*) in a single clump, with an average of 21.1 live bugs per bunch. The counts also showed that Sudan grass, although not as suitable as the native bunch grass, serves as efficient hibernating quarters for the chinch bug.

The tall uncut bunches, or bunches not pastured too closely, which had a dense growth of leaves at the base, furnished the most suitable overwintering quarters for the bugs.

While making a study of the insects attacking sorghums, the writer had an excellent opportunity to study the efficiency of Sudan grass as overwintering quarters for the chinch bug, *Blissus leucopterus* Say. Sudan grass, *Sorghum vulgare sudanensis*, has been gaining in importance as a forage crop throughout the southwestern part of the Great Plains area. The acreage in Kansas has increased from 20,000 acres in 1915 to 190,000 acres in 1924.

Being a native of a hot, dry climate, it is adapted to the relatively dry conditions of this region and thrives under any environment favorable to the growth of other sorghums. It is an annual and is readily adapted to short rotations as a hay, seed, or pasture crop.

Since the Sudan grass bunches resemble very closely the native bunch grasses, one could reasonably assume that the undisturbed clumps might furnish suitable hibernating quarters for the chinch bug. This would be particularly true if the crop were grown in areas where the native clump-forming grasses do not occur.

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[1] Contribution No. 366, Department of Entomology. This paper embodies the results of some of the investigations undertaken by the writer in the prosecution of project No. 92 of the Agricultural Experiment Station.

In Kansas, the chinch bug is the most destructive pest attacking cereal crops. Hence, any cultivated crop which would furnish suitable winter quarters for the bugs would serve as a center of distribution from which the adults would disperse the following spring.

It was with these facts in mind that a study was made to determine the efficiency of Sudan grass bunches as hibernating quarters for this insect.

Review of Literature

In 1894, Marlatt, as a result of chinch bug hibernation studies, pointed out that the normal hibernating quarters for the chinch bug are the dense clump-forming native grasses, "such as the blue stem and other sorts, perhaps including tame varieties which incline to the stooling habit."

Headlee and McColloch (1913) have shown that the chinch bug prefers the type known as the little blue stem (*Andropogon scoparius* Michx.), while the big blue stem (*Andropogon furcatus* Muhl.) and false red top (*Triplasis purpurea* Walt.) also furnish suitable clumps for hibernation.

Hayes (1922) found that many chinch bugs seek winter quarters at the crowns of the Sudan grass plants. Since his observations were preliminary to the present studies, a discussion of his results is embodied in this paper under the heading of presentation of data.

Methods

A study to determine the efficiency of Sudan grass bunches as hibernating quarters for the chinch bug was started in the fall of 1917, but it was not continued throughout the winter. In 1918, five bunches were examined in comparison with several other bunch grasses, but not enough data were secured to warrant satisfactory conclusions. Further counts were made during the winters of 1920–1921 and 1923–1924. More extensive observations were made during the hibernation seasons throughout the winters of 1924–1925, 1925–1926, and 1926–1927. These observations were instituted with the first freezing temperatures in the fall and continued until the first bugs were observed in flight in the spring.

Whenever possible, the counts were made at monthly intervals throughout the winter. At least five bunches were examined from each field for each count. The bunches were dug out with considerable soil attached to the roots in order to avoid disturbing the surface of the soil at the crowns of the plants. These clumps were placed into individual, closely woven sacks, in order to prevent the escape of the bugs when the bunches were subjected to the higher temperatures in the laboratory. When the soil on the bunches was frozen, the sacks containing them were placed in a cool room where the clumps were allowed to thaw out gradually, thus avoiding the effects of a sudden change in temperature.

Careful observations were made regarding the location of the fields from which the bunches came, and the purpose for which the Sudan grass was grown. Notes were also taken on the character of the bunches, i.e., whether grassy, cut, uncut, or pastured and the size of the bunches indicated by their diameters and the number of stems. The location of the bugs in the clumps was also noted.

The counts include a record of the dead chinch bugs as well as that of the live ones in order to determine the rate of mortality during the hibernating season. Some examinations were also made of native bunch grass in order to compare the number of bugs found therein with that in the Sudan grass. Approximately, the same sized bunches were examined in each case.

The observations made during the four seasons—1923 to 1927—were continued throughout the hibernating season, and are believed to be representative of average conditions. The counts for the other years are discussed in the presentation of data, but the mortality counts are based upon the observations of the last three seasons.

PRESENTATION OF DATA

A preliminary examination of 41 bunches of Sudan grass in November, 1917, showed a maximum of 1460 bugs in a single clump, with an average of 117. Counts made on four bunches in 1918 showed an average of only four bugs per bunch.

Hayes (1922) made some observations following the mild winter of 1920–1921 and found a maximum of 27 bugs in one clump. These counts also showed no noticeable difference between the cut and the uncut bunches as a means of protection. Further observations made in November, 1921, following a summer in which the bugs were quite numerous, showed as many as 74 bugs to a clump.

The data presented in Table 1 are a complete record of the counts made during the hibernation period for the past four years. No bunches were examined during December, 1923, October, 1924, or March, 1925, nor during October 1926, or February, 1927. Only the data secured during the hibernation seasons of the last three years were used in calculating the mortality rate. Table 1 shows the total number of clumps examined each month, the number of living and dead bugs and the average number of living and dead bugs per clump.

Table 1—Number of Chinch Bugs in Sudan Grass Clumps During Winters of 1923 to 1927

Month and Year	Total Number of Clumps Examined	Total Number of Bugs		Live Bugs per Clump			Dead Bugs per Clump			Per cent Dead
		Live	Dead	Max.	Min.	Ave.	Max.	Min.	Ave.	
1923–1924										
August	10	2,690		1,053	34	269.0				
September	26	13,130		5,708	2	505.0				
October	13	986		403	1	75.7				
November	20	1,071		263	5	53.5				
December				No counts made						
January	9	181		64	5	20.1				
February	21	754		150	3	35.8				
March	21	274		27	1	13.0				
April	3	15		9	2	5.0				
1924–1925										
October				No counts made						
November	55	377	3	57	0	7.0	3	0	.1	0.8
December	60	475	7	88	0	7.9	7	0	.1	1.5
January	55	51	75	13	0	0.9	25	0	1.3	59.8
February	45	334	45	39	0	7.4	5	0	1.1	1.2
March				No counts made						
1925–1926										
October	25	499	10	199	0	20.0	5	0	.4	.2
November	45	1,193	64	155	0	26.5	22	0	1.6	5.1
December	35	1,582	56	227	0	45.2	12	0	1.6	3.4
January	40	1,132	112	529	0	28.3	32	0	2.5	8.6
February	25	399	34	90	0	15.9	6	0	1.4	7.9
March	15	259	84	78	0	17.2	42	0	5.7	24.5
1926–1927										
October				No counts made						
November	35	474	14	296	0	13.5	8	0	.4	2.9
December	30	323	44	160	0	10.7	36	0	1.1	11.0
January	30	298	76	112	0	9.9	28	0	2.5	20.3
February				No counts made						
March	25	84	0	23	0	3.3	0	0		0

The normal hibernating period extends from October until March, but the length of the period varies with the fall and winter conditions. With high fall temperatures, the bugs are not forced to seek hibernating quarters until November. Occasionally, as in 1924–1925, the bugs were in flight by the latter part of February. These facts must be considered in interpreting the data.

The maximum number per clump was found in August and September, 1923, but these represent the population that had congregated in the Sudan grass for feeding rather than for hibernation. Likewise, counts in April, 1924, were for three bunches taken after the majority of the bugs had left; hence, the data are of no significance in hibernation studies.

During the four year period, a total of 604 bunches, exclusive of those just mentioned, was examined. These showed an average population of 21.1 live bugs per clump. The maximum number in one clump was 540 in January, 1926, of which 11 were dead.

Observations, as well as the data, given in Table 1, under the heading "Percent dead," confirm the belief that the mortality rate increases, from month to month after the bugs go into hibernation, until January or February. After February, the live bugs leave the bunches if the temperature rises, while the dead bugs disintegrate, making an accurate determination of mortality impossible. Nevertheless, the rather large number of living bugs found in the latter part of the winter suggests that Sudan grass affords fairly satisfactory hibernating quarters. The counts during the winter of 1925–1926 are of special interest in this connection, since it was impossible to make counts every month during the hibernating period. The data for this period verify the possibility of chinch bugs using Sudan grass bunches as overwintering quarters when the opportunity permits.

Assuming an average of 21.1 live bugs per clump and 25,000 bunches of Sudan grass, planted in rows, per acre, there would be approximately 500,000 bugs overwintering on one acre. This number would certainly be large enough to warrant the destruction of the bunches to prevent overwintering.

Table 2 shows a comparison of the number of bugs occurring in Sudan grass bunches, taken from various types of fields, and with this is included a record of the examination of 125 bunches of Little Bluestem for the same period, for comparison. The average diameter of all bunches was approximately the same.

Little Bluestem had the largest number, namely, 30.4 per bunch, followed closely by uncut Sudan grass, with an average of 27.1 bugs per clump. Bunches taken from Sudan grass pastures had a population of 13 bugs per clump, while cut stubble showed an average of only seven bugs per clump.

The most attractive overwintering quarters are furnished by those bunches which consist of a large number of stems with a dense growth of leaves at the base. The tall volunteer, uncut bunches, or those not pastured too closely, were selected by the bugs as the most suitable. Stubble cut very short has practically no growth of leaves at the base, and hence furnishes very little protection.

TABLE 2. COMPARISON OF THE NUMBER OF BUGS FOUND IN THE DIFFERENT TYPES OF BUNCHES OF SUDAN GRASS AND IN LITTLE BLUESTEM

Type of Bunch	Number of Bunches	Average Diameter of Bunches	Total Number of Bugs	Average Number of Bugs per Bunch
Sudan grass cut (stubble)....	180	5.20 in.	1,255	7.0
Pastured......	165	3.97 in.	2,145	13.0
Uncut.........	175	4.66 in.	4,736	27.1
Little Bluestem	125	5.00 in.	3,795	30.4

Additional evidence that chinch bugs will select Sudan grass is afforded by an examination of Sudan grass fields adjacent to cornfields which had a heavy infestation of bugs the previous summer. In one instance, where a Sudan grass pasture was near such a cornfield, there was no significant difference between the average number of bugs found in the native bunch grass and in the Sudan grass.

As a rule, the native bunch grass is preferred by the bugs. This, no doubt, can be attributed to the fact that the bunch grass offers more protection due to a denser growth of stems and the accumulation of loose, dead material at the crowns of the plant.

There seems to be no relation between the diameter of the bunches and the number of bugs found in them. Bunches of sufficient size to collect the snow and those not exposed to the sudden changes in temperature seem more satisfactory as hibernating quarters.

Closely pastured bunches in feed lots, where livestock was allowed to tramp over them, were rendered unfit for hibernating purposes. A few counts in such bunches during the early part of the hibernating period showed large numbers but, as the season progressed, the bunches became badly tramped, causing a loss of practically 100 per cent of the bugs at the close of the season.

SUMMARY

1. Sudan grass serves as an efficient hibernating quarter for the chinch bug. The largest number of live bugs found during the hibernating period in any clump was 529, while the average number per bunch was 21.1.

2. Sudan grass bunches that have not been too closely pastured, or tall, uncut bunches which have a dense growth of leaves at the base, furnish the most suitable overwintering quarters for the chinch bug.

3. The counts indicate that the native bunch grasses furnish the favorite hibernating quarters for the chinch bug.

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EXPLORATION IN THE ARGENTINE REPUBLIC FOR PARASITES OF THE BEET LEAFHOPPER, *EUTETTIX TENELLUS* (BAKER)[1]

By CHARLES F. HENDERSON

ABSTRACT

Because of reports that the beet leafhopper, *Eutettix tenellus* (Baker), as well as Argentine curly top of sugar beets which is transmitted by *Agallia sticticollis* Stal, was found in the Argentine Republic, an exploration was undertaken in that country for parasites of the insect. Investigations covering a period of seven and one-half months were conducted in the provinces of Tucuman, San Juan, Mendoza, Buenos Aires, and the territories of La Pampa and Rio Negro. Beets having typical curly top foliage symptoms were found in all of these localities excepting Rio Negro, although no beet leafhoppers were taken. Favorable host plants belonging to the Chenopodiaceae and other families were swept without a single specimen of *E. tenellus* being captured. These plants included the most important food and breeding plants of the insect in California, viz., Australian saltbush (*Atriplex semibiccata*), red orache or red scale (*A. rosea*), Russian thistle (*Salsola kali*), red stem filaree (*Erodium cicutarium*), and nettle leaf goosefoot (*Chenopodium murale*). Insect collections of several museums and private entomologists were examined and no beet leafhoppers were present. The *Eutettix* sp., which greatly resembles *E. tenellus*, was captured in almost every locality in which beets or Swiss chard were growing.

INTRODUCTION

According to Boncquet (1) the beet leafhopper, *Eutettix tenellus* (Baker) and curly top of sugar beets occurred in the Argentine Republic at Buenos Aires, Bahia Blanca, Guatrache, Alpachiri, Mendoza and Colonia Alvear.

Fawcett (2) demonstrated that a disease of sugar beets in the Argentine, resembling the foliage symptoms of curly top of North America, was transmitted by *Agallia sticticollis* Stål.

Because of these reports of the presence in Argentina of the beet leafhopper[2] and a disease resembling curly top of sugar beets, an exploration to that country in search of parasites of the insect was undertaken by the University of California, in cooperation with the Bureau of Entomology, United States Department of Agriculture.

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[1] Contribution from the Division of Entomology and Parasitology, College of Agriculture, University of California, cooperating with the United States Department of Agriculture, Bureau of Entomology.

[2] The common name, beet leafhopper, throughout this article refers only to *Eutettix tenellus* (Baker).

The writer sailed for the Argentine Republic, leaving San Francisco on October 9, 1926, aboard the West Mahwah, and arrived at Ingeniero White, the port of Bahia Blanca, on November 10, 1926. A trip was made on the following day to Buenos Aires where his credentials were presented at the American Embassy and Consulate, and to Argentine authorities. Investigations were conducted in the provinces of Tucuman San Juan, Mendoza, Buenos Aires, and the territories of La Pampa and Rio Negro, covering a period of seven and one-half months.

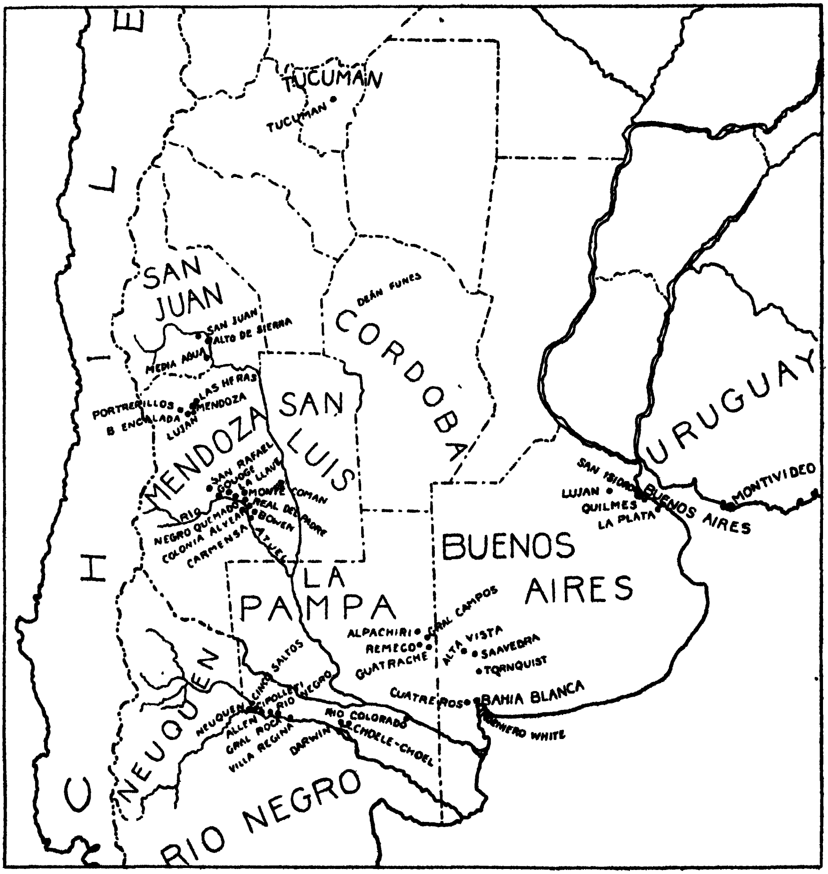

FIG. 59—Map of the Argentine Republic and Uruguay showing the localities investigated for the beet leafhopper.

PROVINCE OF TUCUMAN

November 18–24, May 31–June 26

After spending a few days in the suburbs of Buenos Aires, the writer left for Tucuman where his arrival at the agricultural experiment station had been anticipated somewhat earlier. The director of the station, Dr. Wm. Cross, generously offered all necessary laboratory facilities for the work in Tucuman, and had made an additional planting of sugar beets so that young as well as old beets would be present upon my arrival.

An investigation was made concerning the Argentine curly top, and the leafhoppers found on sugar beets and favorable weeds in the vicinity of Tucuman. The experimental sugar beet plantings of Mr. Fawcett showed that 100 per cent of the large beets and two to fifty per cent of the small beets were diseased (Table 1). These beets were swept with an insect net over a period of several days and not a single specimen of the beet leafhopper (*Eutettix tenellus*) was captured. Nettle leaf goosefoot (*Chenopodium murale*), a favorable food and breeding plant of the insect in the cultivated areas of California (3) was also swept, but with negative results.

TABLE 1. LOCALITIES SHOWING PERCENTAGE OF ARGENTINE CURLY TOP OF RED BEETS, SUGAR BEETS, AND SWISS CHARD

Province or Territory	Locality	Red Beets	Sugar Beets Approx. Acreage	Swiss Chard	Percentage Curly Top
Tucuman	Tucuman		2		2–50 100*
Buenos Aires	Punta Chica, Victoria, Tigre, Quilmes, Caseros, Lujan, San Isidro, and suburbs of Bahia Blanca.	many small plots		many small plots	low† to 100
San Juan	San Juan		2½		1–
	Media Agua		2½		0
Mendoza	Mendoza, Lujan de Cuyo, Las Heras	few small plots		2 plots	50–100
	San Rafael	few plots	1½		0
	Goudge		10		0
	Colonia Alvear	few plots			5–75
La Pampa	Guatrache	1 plot	1/20		1–
Rio Negro	Cinco Saltos, Choele-Choel	few small plots			0
	Villa Regina		¼		0

*2–50% refers to small beets from 4–6 inches in height. 100% in the large beets.

†Low—100% depending upon time of inspection which covered a period of five months for these particular localities.

After discussing his experiment on the transmission of the Argentine curly top with Mr. Fawcett, the sugar beets infected by *A. sticticollis* in cages, as well as the healthy check plants were examined. The details concerning his work have been published in a recent paper, (2).

Collections of leafhoppers made previously by Mr. Fawcett on sugar beets were examined, but no *E. tenellus* were found. The insect collection of the University of Tucuman was also inspected with the assistance of Mr. Rodolpho Schreiter, the entomologist in charge, but no beet leafhoppers were present.

An examination of the weather records of the Tucuman Agricultural Experiment Station (5) for the past fifteen years shows an average yearly rainfall of 35.8 inches at Tucuman, and a much greater amount occurs in the heavily forested foothills of the Andes which are not far distant. If California rainfall records (4) are taken as indicative of conditions in its natural breeding grounds, it is evident that the Province of Tucuman does not furnish a favorable environment for the insect.

A study of the rainfall records and the alkalinity of soil and water indicated that the provinces of San Juan and Mendoza presented more favorable beet leafhopper conditions than Tucuman. The annual rainfall in certain localities in Mendoza averaged from 10 to 13 inches, and the water was alkaline, indicating the possible presence of alkali-loving plants of the family Chenopodiaceae to which the sugar beet belongs. The beet leafhopper had been recorded from this province by Boncquet.

Observations made by train between Tucuman and San Juan revealed a type of country which was obviously not adapted to *E. tenellus*, and whenever the train stopped for sufficient time various species of chenopodia including *Chenopodium murale* were swept with negative results. As the province of San Juan was approached the country began to assume a more favorable aspect, resembling somewhat parts of the Imperial Valley of California. *Atriplex spp.* and other desert vegetation were very plentiful.

PROVINCE OF SAN JUAN

November 26–December 1

The Experimental Station of San Juan at Alto de Sierra was visited and the director, Guillermo Renate Aubone, exhibited the two and one-half acres of sugar beets with the information that this and a similar plot at Media Agua were the only plantings in the province. The Azucarera de Cuyo is being formed at Media Agua, and is to be the first beet sugar company in the Argentine Republic. Media Agua is an irrigated district about thirty miles southeast of San Juan.

Although *A. sticticollis* was quite abundant, only two diseased beets were found and these were at Alto de Sierra.

PROVINCE OF MENDOZA

December 2-January 15

Red, garden, or table beets, sugar beets, and Swiss chard were swept at Lujan de Cuyo, Las Heras, San Rafael, Goudge, and Colonia Alvear, but no beet leafhoppers were collected. The fairly high percentage of curly top noted in this province is shown in Table 1.

A species of *Eutettix* closely resembling *E. tenellus*, although differing in the structure of the female genitalia was found quite abundantly here. This insect has been determined by Professor Herbert Osborn from material sent to him by the writer as an undescribed species of *Eutettix*.

The beet leafhopper was not taken on Russian thistle (*Salsola kali*) which grew profusely along roadsides, irrigation canals, bordering cultivated fields, and in vacant lots near the Experimental Station of Mendoza situated at Goudge, and at La Llave. Enormous multiplication of this hopper occurs on Russian thistle in the western part of the United States as determined by previous investigators. The insect was not collected on Australian saltbush (*Atriplex semibiccata*) growing in the vicinity of Colonia Alvear. This perennial *Atriplex* is an important food and breeding plant in California (3). No beet leafhoppers were captured on plants of the Chenopodiaceae and other families as indicated in the following list of plants swept in this vicinity. These plants were identified by Dr. Alberto Castellanos of the Natural History Museum of Buenos Aires.

- Polygonaceae
  - *Rumex* sp.
- Chenopodiaceae
  - *Chenopodium rubrum* Linn.
  - *C. hircinum* Schrader
  - *Atriplex* spp. (perennials)
  - *A. platensis* Speg.
  - *A. lampa* Gill.
  - *A. semibiccata* R. Br.
  - *A. undulata* Moq.
  - *A. hastatum* Linn.
  - *Salsola kali* Linn.
  - *Suaeda divaricata* Moq.
- Amaranthaceae
  - *Amaranthus* spp.
- Arzoaceae
  - *Sesuvium portulacastrum* Linn.

The beet leafhopper has been taken on *S. portulacastrum* in Florida by de Long (6).

The foothills of the Andes near Mendoza as far as Portrerillos on the Transandine Railroad were visited and found to be dry, rocky, and sparsely covered with desert vegetation. In the small valley of Portrerillos where the soil was less dry, red stem filaree (*Erodium circutarium*), the most important winter host plant of the beet leafhopper on the plains and foothills in the dry interior regions of California (3) was found to be abundant, though dwarfed.

The insect collection of the Educational Museum of Mendoza was examined and the director, Dr. Carette, exhibited the Carlos Reed Collection of Mendozan insects. Reed collected extensively in the province, and while the Hymenoptera were largely represented, there were also many homopterous insects. No. *E. tenellus* were found in these collections.

PROVINCE OF BUENOS AIRES

November 10–16, January 29–February 16, March 6–21, April 18–May 30

Red beets and Swiss chard often showing 100 per cent curly top (Table 1) were found in the following suburbs of Buenos Aires: Punta Chica, Victoria, Tigre, Quilmes, Caseros, Lujan, and San Isidro; and in the vicinity of Bahia Blanca. Farmers stated that at times the Swiss chard was so stunted and malformed as to be unmarketable. No beet leafhoppers were taken on these crops, but *A. sticticollis* and *Eutettix* sp. were present in about equal numbers. In the course of this exploration wherever the disease occurred *Agallia sticticollis* was also found.

The beet leafhopper was not taken on Russian thistle growing in the suburbs of Bahia Blanca and in the cultivated districts between Tornquist, Saavedra, and Alta Vista, nor on the Australian saltbush and perennial atriplexes in the vicinity of Bahia Blanca. Scattered plants of red stem filaree had just germinated in the foothills of the Sierra de la Ventana at Tornquist and Pigue and in the cultivated areas near Tornquist.

The insect collection in the Museum of the University of La Plata was examined and here was found the famous old collection of Carlos Berg. Some of the leafhoppers collected by Berg had been sent to Stal at the National Museum of Stockholm and the type specimens are on deposit there. This collection had been saved from total destruction after Berg's death by Dr. Carlos Bruch, although many of the type specimens had been lost. The leafhoppers in the Museum's collection were examined but no beet leafhoppers were found. Specimens of *E. tenellus* from California were shown to Dr. Bruch at his home in Olivos but he stated that he had never taken this insect in his many years of collecting in the Argentine Republic.

The collection of the National Museum of Natural History at Buenos Aires was also examined. Dr. Brethes, curator of the insect collection, had stated in previous correspondence with the writer, that no specimens of the beet leafhopper existed in this collection and that he was of the opinion that the insect was essentially North American.

The collection of Dr. Miles Stuart Pennington at Quilmes and Buenos Aires which includes the leafhoppers of the Carlos Lizer collection from Bolivia, was also investigated but no specimens of the beet leafhopper found.

TERRITORY OF LA PAMPA

February 16–March 6

A trip was taken to Guatrache where the Experiment Station of La Pampa Central was visited. A small patch of sugar beets was found in the garden of the director, Mr. Alberto Cortelue. No beet leafhoppers were taken although a few plants having typical symptoms of curly top were found (Table 1).

Russian thistle and *A. rosea* were swept in the vicinity of Guatrache, Alpachiri, Remeco, and General Campos, without taking a specimen of *E. tenellus*. These weeds were exceedingly abundant, not only bordering roads and fences, but covering vast acreages of stubble land as well.

TERRITORY OF RIO NEGRO

March 21–April 17

Red beets and sugar beets were swept in the territory of Rio Negro at Cinco Saltos, Villa Regina, and Choele-Choel but no beet leafhoppers were taken and no curly top symptoms were noted in any of the plants.

Another disease had previously destroyed all sugar beets at the Experiment Station of Rio Negro near General Roca, and had left only one plot at the colony of Villa Regina, where previous to December, there had been several plantings. According to Director Bignami of the colony, this disease occurred with the first high temperatures in December and plants which were large and apparently healthy suddenly wilted and died, often within a single day. Various scientists of the region had examined the diseased plants but were unable to determine the cause. The remaining plot was examined for curly top but no symptoms of the disease were found.

Favorable host plants such as Russian thistle and annual atriplexes were found on the floor of the valley, but in such a dry condition that leafhoppers were very scarce. *Chenopodium rubrum* was the only possible host plant still in a green and succulent condition. Although this plant occurs in California it is not known to be a favorable host plant of *E. tenellus*. An abundance of Australian saltbush was found in and near the village of Rio Colorado along roadsides, fences, ditches, and covering vacant fields. This plant and annual atriplexes were swept on several occasions without a single specimen of *E. tenellus* being taken.

PLANTS OF CHENOPODIACEAE EXAMINED FOR *Eutettix tenellus* (BAKER) IN THE ARGENTINE REPUBLIC

The following chenopods collected in the Argentine Republic, in addition to those listed under the Province of Mendoza, were swept with an insect net for *E. tenellus*. These plants were determined by Dr. I. M. Johnston of the Gray Herbarium.

Allenrolfia patagonica (Moq.) Kuntze
Atriplex hortense L.
A. montevidensis Spreng.
A. rosea L.
A. sagittifolia Speg.
A. tatarica L.
A. vulgatissimum Speg.
Chenopodium ambrosioides L.
Salicornia fruticosa Auct. Argent.
S. gaudichaudiana Moq.
Senecio mendocinus Ph.
Suaeda maritima L.
Spirostachys ritteriana (Moq.) Ung.-Stern
S. rotteriana (Moq.) Ung.-Stern.

URUGUAY

January 24–28

A short trip was made to La Sierra, Uruguay, for the purpose of visiting twelve hundred acres of sugar beets planted by the Diaz-Aznaz Company, before the crop had been harvested. This operation was at its height, and it is interesting to note that the beets were plowed up by ox plows and hauled to the mill in ox carts. The beets were small and a very poor stand was evident. No beet leafhoppers were taken nor were any curly top beets found. *A. sticticollis* was scarce but the relative abundance could not be determined accurately owing to heavy winds.

ACKNOWLEDGMENTS

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deserve special mention for their assistance in the examination of museum collections: Drs. Juan Brethes, Carlos Bruch, Miles Stuart Pennington, and Rodolpho Schreiter. Mr. Granell and Dr. Carlos Lizer of the Argentine Department of Agriculture, Dr. Eduardo Carette and Francisco Croce of Mendoza, and the directors of state and railroad company experimental farms also deserve credit for their wholehearted cooperation.

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THE DEVELOPMENT AND PRESENT STATUS OF ENTOMOLOGICAL COURSES IN AMERICAN COLLEGES AND UNIVERSITIES

By PAUL KNIGHT, *Instructor in Entomology, University of Maryland*

ABSTRACT

This is the first of three papers on the teaching of elementary entomology, and will serve as the introduction to the succeeding publications. It traces the history of teaching in this country and gives a fairly comprehensive idea of the extent of the academic work today. That the historical information and data on the number of courses is incomplete has been shown by a recent paper by R. C. Smith, in the Kansas State Agricultural College Bulletin, Vol. 12, No. 1, Jan. 1928. The two papers taken together throw light on these subjects.

In entomology as in all other sciences the development of formal courses has been behind the development of the science itself. Up to the final quarter of the nineteenth century little research work had been accomplished in American entomology, which necessarily meant little development of courses. With the establishment of the Land Grant Colleges, experiment stations, libraries, museums, insect collections, and the Bureau of Entomology, the development of courses for the training of entomologists likewise began to develop. However, this progress is still subordinated to research work in most institutions.

The early development of American entomology has some very interesting chapters. We all know of the work of Peck, Harris, Walsh, Thomas, LeBaron and many others. Good accounts of their work have appeared in various publications. There is nothing very illuminating in regard to the development of early courses, and of the men in charge of them. Little had been done previous to 1862, the date marking the Morrill Bill, which was responsible for the establishment of the state agricultural colleges and some of the state universities of this country. Previous to this legislation there had been several attempts to establish schools of this nature. All except the old Maryland Agricultural College, chartered in 1856, and Michigan Agricultural College, founded in 1857, proved dismal failures.

Dr. H. A. Hagen of Harvard University is usually credited with being the first teacher of entomology in America, though a little investigation shows several men preceded him. Hagen came to Harvard in 1870, but his first course was not offered until 1873. This course consisted of a single student, J. H. Comstock. Hagen was not an economic entomologist, and had he been he would have found a dearth of teaching materials. His equipment was negligible, except for an enormous library which he brought from Europe. He imparted most of his knowledge to his students by informal lectures. A pencil and paper was his blackboard. Thomas Say taught at the University of Pennsylvania at a much earlier date, but whether entomology was among his subjects is not known. Say's American Entomology was published in 1824, at which time he was "Professor of Natural History," in the University, and had been for several years. It is hard to imagine Say occupying a chair of natural history and not teaching insect study. Townend Glover was appointed to a professorship at the institution now known as the University of Maryland at a very early date, but his work was largely if not wholly along other lines. Packard had given a few lectures at Orono, Maine, and Burrill, though primarily a botanist, was teaching entomology at the University of Illinois as early as 1869. Thomas Bessey taught entomology along with zoology at Iowa State College in 1870. Shortly after this time Fernald started teaching at the University of Maine, and Comstock at Cornell University. As far as can be ascertained these were the only courses taught previous to 1880, at which time many institutions adopted the science as a useful one.

The early entomologists were forced to get their training in any way they could, but the results of their work has been the development of a number of extensive departments for the training of present day workers. These are primarily in the state institutions. Through the courtesy of Dr. L. O. Howard I am able to give figures on the academic training of the entomologists of the United States Department of Agriculture. These are correct to January 1927. This tabulation gives a comprehensive idea of the training of entomologists for economic work. Obviously not all the degrees represent major work, as many are conferred by institutions not offering a single course in entomology. This is even true of several of the doctorates represented. However, the largest percentage come from institutions where much effort has been expended towards the development of the department. This table is not however an accurate index to the extensiveness of all departments, as some departments have furnished multitudes of workers to colleges and experiment stations and only a few to the government service.

Name of Institution	Degrees Represented		
	Bachelors	Masters	Doctors
Alabama Polytechnic Institute	3	1	1
Baker University	1		
Beloit College	1	1	
Boston University	1		
Bowdoin College	1		
Clark University	2		
Clemson Agricultural College	12		
Colorado Agricultural College	2		
Columbia University	2	1	11
College of Texas	1	1	
Connecticut Agricultural College	7		
Cornell University	12	7	3
Dartmouth College	1		
Davis Elkins College	1		
Elmira College	1		
Georgetown University			1
George Washington University	2	2	6
Harvard University	1	3	
Iowa State College	2	2	
Kansas Agricultural College	10	4	1
Knox College	1		
Leland Stanford Jr. University	7	3	2
Louisiana State University	1	1	
Massachusetts Agricultural College	40	3	4
Massachusetts Institute of Technology	1		
Michigan Agricultural College	4		
Mississippi A. and M. College	25	2	
Montana State Agricultural College	3		
North Carolina State College		1	
New York State College of Forestry	1		
Ohio State University	9	6	5
Ohio Northern University	1		

Name of Institution	Degrees Represented		
	Bachelors	Masters	Doctors
Oklahoma A. and M. College	1	1	
Oregon Agricultural College	2		
Pennsylvania State College	6		
Princeton University		1	
Purdue University		2	
Pomona College	3		
Rutgers College	1	1	1
Radcliffe College	1	1	
Rhode Island State College		1	
Saint Maximin College			1
Simmons College	1		
South Dakota State College	1		
Syracuse University	1		
Texas A. and M. College	2		
Tulane University			1
University of California	4	3	
University of Colorado		1	
University of Delaware		1	
University of Denver	1		
University of Florida	2	1	
University of Idaho	2		
University of Illinois	6	6	1
University of Indiana	1	1	
University of Kansas	3		
University of Kentucky	1		
University of Maryland	5	3	1
University of Michigan	1	2	
University of Minnesota	5	3	
University of Missouri	1	1	
University of Montana	1		
University of Nebraska	1		
University of New Hampshire	5		
University of Pennsylvania	4	3	2
University of Pittsburgh	1		3
University of South Carolina		1	
University of Southern California		3	
University of Tennessee	4	1	
University of Utah	2		
University of Virginia		1	1
University of Wisconsin	3	3	
Utah Agricultural College	2		
Vanderbilt University	1		
Virginia Polytechnic Institute	3	1	
Wabash College	1		
Washington University			1
Washington State College		3	
Washington State University	2		
Western Reserve University	1		
West Virginia University		1	

According to Needham (Bureau of Education Bulletin 1925–4), by the latter part of the nineteenth century every Land Grant institution at that time established was teaching at least one course in entomology, while a few had made greater progress. A survey of these institutions by Jarvis, (Bureau of Education Bulletin 1918–29) shows that every Land Grant school required at least one course in entomology of its agricultural students, while 17 were offering major work in this department. These were the University of California, Colorado Agricultural College, University of Illinois, University of Kentucky, Massachusetts Agricultural College, University of Minnesota, Mississippi Agricultural and Mechanical College, University of Nebraska, Cornell University, Ohio State University, Oregon Agricultural College, Clemson Agricultural College, University of Tennessee, Texas Agricultural and Mechanical College, Agricultural College of Utah, West Virginia University, and the University of Wisconsin. The present study shows Jarvis' data to be incomplete, and at least the following should be added; Connecticut Agricultural College, Kansas Agricultural College, North Carolina State College, University of New Hampshire, University of Missouri, University of Maryland, and Virginia Polytechnic Institute. Today there are said to be more teachers of entomology in the United States than in the entire rest of the world.

The following survey of the series of college and university catalogues in the Library of Congress shows the extent of collegiate entomology. This is as correct as it is possible to make it, to January 1927.

Institution	Dept. of	Number of Undergrad. Courses	Grad. Work Given	Size of Teaching Staff	Major in Entom.
Alabama Polytechnic Institute	Zoo.-Ent.			3	
Alaska Agricultural College	Agr.	1		1	
Arziona, University of	Biol.	1		1	
Arkansas, University of	Ent.	1		2	
Augustana College	Biol.	1		1	
Baylor University	Zool.	1		1	
Bucknell University	Biol.	1		1	
California, University of	Parasitol.-Ent.	15	x	5	x
Colorado Agric. College	Ent.-Zool.	11	x	5	x
Colorado College	Biol.	1		1	
Colorado University	Biol.	2	x	1	
Catholic Univ. of America	Biol.	1		1	
Clemson College	Zool.-Ent.	13	x	3	x
Connecticut Agric. College	Zool.	4		4	x
Cornell University	Ent.-Limn.	20	x	12	x
Denison University	Zool.	1		1	

Institution	Dept. of	Number of Undergrad. Courses	Grad. Work Given	Size of Teaching Staff	Major in Entom.
Denver, University of	Zool.	2	x	1	
DePauw University	Zool.	1		1	
Earlham College	Zool.	1		1	
Eureka College	Zool.	2		2	
Florida, University of	Zool.	2		2	
Franklin & Marshall College	Biol.	1		1	
Georgia, University of	Zool.	1		1	
Harvard University	Zool.	3	x	2	x
Hawaii, University of				1	
Hillsdale, College	Biol.	1		1	
Idaho, University of	Zool.-Ent.	6	x	2	x
Illinois, University of	Ent.	17	x	8	x
Indiana University	Zool.	3	x	1	
Iowa State College	Zool.-Ent.	20	x	7	x
Iowa, University of	Zool.	3		1	
Jamestown College	Biol.	1		1	
Johns Hopkins University	Medic.-Zool.	1	x	2	
Kansas Agricultural College	Ent.	19	x	5	x
Kansas, University of	Ent.	16	x	4	x
Kentucky, University of	Ent. (1)	4	x	2	x
	Zool. (2)	8	x	2	
Leland Stanford Jr. Univ.	Ent.	18	x	3	x
Louisiana State University	Ent.	6		1	x
Louisville, University of	Zool.	1		1	
McKendree College	Biol.	1		1	
McPherson College	Biol.	1		1	
Maine, University of	Biol.	3		1	
Maryland, University of	Ent.	13	x	2	x
Massachusetts Agric. College	Ent.	17	x	4	x
Michigan Agricultural College	Ent.	15	x	5	x
Michigan, University of	Zool.	2		1	
Minnesota, University of	An. Biol.	4	x	6	x
Mississippi A. & M. College	Zool.-Ent.	4		3	x
Missouri, University of	Ent.	14	x	2	x
Monmouth College	Biol.	1		1	
Montana, University of	Biol.	2		1	
Nebraska, University of	Ent.	10	x	4	x
Nevada, University of	Ent.			2	
New Hampshire, University of	Ent.	7	x	2	x
New Mexico, College of Agric.	Biol.	2		1	
New Mexico, University of	Zool.	2		1	
New York University	Biol.				
Notre Dame University	Zool.	2		1	
Ohio University	Biol.	2		1	
Ohio Northern University	Biol.	1		1	
Ohio State University	Zool.-Ent.	7	x	5	x

Ohio Wesleyan University	Zool.	1		1	
Oklahoma Agric. College	Ent.	5		3	
Oklahoma, University of	Zool.	1	x	1	
Oregon Agricultural College	Ent.	13		4	x
Ottawa University	Zool.	1		1	
Otterbein University	Biol.	1		1	
Pennsylvania State College	Zool.-Ent.	8	x	7	x
Pennsylvania, University of	Zool.				
Pomona College	Zool.	1		1	
Porto Rico, University of				1	
Purdue University	Ent.	6	x	4	x
Rhode Island State College	Zool.	3		1	
Richmond, University of	Biol.	1		1	
Rochester, University of	Biol.	1		1	
Rutgers College	Ent.	7	x	2	x
Saint Lawrence University	Biol.	2		1	
Saint Viators College	Zool.	1		1	
Smith College	Zool.	1		1	
South Dakota State College	Zool.-Ent.	9		3	x
South Carolina, University	Zool.	1		1	
Syracuse University	Zool. (3)	1		1	
	Forest Ent. (4)	10	x	3	x
Temple University	Biol.	1		1	
Tennessee, University of	Ent.	6	x	2	x
Texas A. and M. College	Ent.	14	x	3	x
Utah Agricultural College	Zool.-Ent.	9	x	3	x
Utah, University of	Zool.	3		1	
Vermont, University of	Zool.	1		1	
Washburn College	Zool.	1		1	
Washington State College	Zool.	11	x	1	x
Washington, University of	Zool.	1		1	
Wesleyan University	Biol.	1		1	
West Virginia University	Ent.	8	x	2	x
Wisconsin, University of	Ent.		x	4	x
Wyoming, University of	Zool.	3	x	1	
Yale University	Zool.	1		1	
	99	453	37	209	36

The following is an incomplete list of Canadian institutions teaching entomology. The catalogues of these are not generally available.

Agricultural College of Nova Scotia
University of British Columbia
McGill University, (MacDonald College)
Ontario Agricultural College
Queens University
University of Quebec
University of Toronto

EFFECT OF EARLY SUMMER AND LATE SUMMER WHITE OIL AND NICOTINE SULFATE SPRAYS ON THE NUMBER OF EGGS OF THE EUROPEAN RED MITE OVERWINTERING ON PEACH TREES[1]

By BYRLEY F. DRIGGERS, Ph.D., *Assistant Entomologist, New Jersey Agricultural Experiment Station*

ABSTRACT

Nicotine Sulfate (1-800) and white oil emulsion (1.0%) applied to peach trees in May and June were not effective in preventing the subsequent deposition of overwintering eggs of the European Red Mite. Nicotine Sulfate and ground tobacco dust were also ineffective in reducing the number of overwintering eggs when treatments were applied in August. Four applications in August on peaches of a one per cent white oil emulsion, gave a reduction of 98.9 per cent in the number of overwintering European Red Mite Eggs on peaches.

Experiments with nicotine sulfate and white oil emulsion were carried on in the summer of 1927 in an effort to control the Oriental Fruit Moth on peaches. All of the trees in a seven-acre orchard of Elberta and Iron Mountain peaches were sprayed with nicotine sulfate (1–800) at weekly or ten-day intervals beginning May 4th and continuing to June 15th. A total of five applications were made. All of the trees of a half-acre orchard adjoining the seven-acre orchard were sprayed with a one per cent white oil emulsion on the same dates that the nicotine sulfate spray was applied. A few peach trees were also sprayed in August with nicotine sulfate (1–800) and white oil emulsion (1%) in an effort to control the Oriental Fruit Moth by spraying for the third brood eggs and larvae.

The control of the Oriental Fruit Moth by the spray operations outlined above did not prove satisfactory. However, they afforded an opportunity to determine the effect of oil and nicotine sulfate, applied early in the summer and late in the summer, on the number of eggs of the European Red Mite overwintering on peach trees. Oil emulsions as growing season insecticides on fruit trees are being given considerable attention. It is desirable to know what effect a summer oil spray, developed for another insect, will have on red mites. The data presented in this paper show the effect on the number of overwintering eggs of the European Red Mite of certain sprays applied in an effort to control the Oriental Fruit Moth.

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[1] Paper of the Journal Series, New Jersey Agricultural Experiment Stations Department of Entomology.

OVERWINTERING EUROPEAN RED MITE EGGS FOUND ON PEACH TREES SPRAYED IN MAY AND JUNE WITH OIL EMULSION AND NICOTINE SULFATE

Twigs were collected from the orchard sprayed with oil emulsion and from the orchard sprayed with nicotine sulfate and the number of live and dead eggs recorded March 10th–14th, 1928. Five trees at equal intervals across the center of each of the two orchards were selected. Ten twigs six inches in length were collected from each tree. The twigs were cut in such a way that equal amounts of the current and preceding season's growth were obtained. It was found that there was less variation in the number of eggs on twigs from the same tree when this procedure was followed.

The twigs were examined under a binocular microscope and the number of live and dead eggs recorded. The egg counts on ten twigs obtained from five trees in the nicotine sulfate sprayed orchard are given in Table 1. The egg counts obtained from the same number of twigs and trees in the oil sprayed orchard are set forth in Table 2.

TABLE 1. NUMBER OF LIVE AND DEAD OVERWINTERING EUROPEAN RED MITE EGGS FOUND ON TEN TWIGS FROM TREES SPRAYED FIVE TIMES WITH NICOTINE SULFATE (1–800) IN MAY AND JUNE

Tree Number	Number of Eggs		
	Live	Dead	Total
1	3153	2459	5612
2	399	2191	2590
3	1125	2314	3439
4	1504	1781	3285
5	1772	3217	4989
Total	7953	11962	19915

TABLE 2. NUMBER OF LIVE AND DEAD OVERWINTERING EUROPEAN RED MITE EGGS FOUND ON TEN TWIGS FROM TREES SPRAYED FIVE TIMES WITH WHITE OIL EMULSION (1%) IN MAY AND JUNE

Tree Number	Number of Eggs		
	Live	Dead	Total
1	1640	2902	4542
2	1089	3086	4175
3	1597	2406	4003
4	182	2839	3021
5	409	3199	3608
Total	4917	14432	19349

The data presented in Tables 1 and 2 show that there were a large number of red mite eggs deposited on the twigs whether the trees were sprayed with oil emulsion or nicotine. All of the trees in the two orchards were sprayed, therefore no check trees were available for a comparison. However, the number of eggs found indicate that the delayed dormant oil spray in this orchard is advisable.

The infestation of red mites in the two orchards shortly after the last spray applications were made was not determined. Data published recently by Newcomer and Yothers[2] show that lubricating oil sprays used at dilutions containing 0.5 or 0.67 per cent oil killed practically 100 per cent of the mites and most of the summer eggs. These investigators found that nicotine sulfate alone killed less than 50 per cent of the mites. In the light of these data it would appear that the five applications of 1 per cent oil emulsion at weekly intervals gave a clean-up of red mites in May and June. If this was the case the small number of mites remaining in the orchard, or brought in from outside sources, multiplied rapidly enough to restock the orchard with overwintering eggs in the late summer and fall.

EFFECT OF LATE SUMMER APPLICATIONS OF OIL EMULSION AND NICOTINE SULFATE ON THE NUMBER OF OVERWINTERING EUROPEAN RED MITE EGGS

A count of twigs injured by larvae of the first brood of the Oriental Fruit Moth was made shortly after the last of the five applications was made in June. The data indicated that the first brood larvae had not been reduced sufficiently to obtain a satisfactory control. Therefore a small scale experiment was carried out in an effort to control the third brood larvae of Oriental Fruit Moth using nicotine and white oil emulsion.

Six Elberta peach trees were selected near the center of the seven-acre orchard which had been sprayed early with nicotine sulfate. The trees were treated as follows: Number 1 was dusted three times at weekly or ten-day intervals with about a half pound of "R-40" ground tobacco dust (1.25% nicotine); number 2 was left untreated; number 3 was sprayed four times with 1 per cent white oil emulsion; number 4 was left untreated; number 5 was sprayed four times with nicotine sulfate (1–800) and number 6 was left untreated. The first application was put on August 4th and the last application August 25th.

Ten twigs were collected from each of the six trees and the number of live and dead eggs recorded March 12th–14th, 1928. It was found that there was a reduction of over 98 per cent in the number of eggs found on the tree sprayed with the oil emulsion. A second series of ten twigs from each tree were examined with results similar to the first series examined. The data obtained from the count of eggs on twenty six-inch twigs from each of the six trees are presented in Table 3.

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[2] E. J. Newcomer and M. A. Yothers. Experiments for the Control of the European Red Mite and Other Fruit-tree Mites. U. S. D. A. Technical Bul. 25.

TABLE 3. NUMBER OF OVERWINTERING EUROPEAN RED MITE EGGS FOUND ON PEACH TREES TREATED WITH GROUND TOBACCO DUST, NICOTINE SULFATE (1–800) AND "VOLCK" OIL EMULSION (1%)

Tree Number	Material Used	No. Twigs Counted	Date Twigs Were Sprayed	Date Twigs Were Examined	No. of Eggs Live	No. of Eggs Dead	No. of Eggs Total	Per cent Reduction
1	Ground tobacco dust	20	3 times in Aug.	March 12th–14th	3338	4475	7813	0.0
2	Nothing	20	———	"	2588	4784	7372	—
3	1.0% white oil emulsion	20	4 times in Aug.	"	30	44	74	98.9
4	Nothing	20	———	"	2453	4113	6566	—
5	Nicotine sulfate	20	4 times in Aug.	"	2271	2796	5067	29.2
6	Nothing	20	———	"	2754	4788	7542	—

The data in Table 3 show that the ground tobacco dust had no effect on the number of overwintering European Red Mite eggs; that the nicotine sulfate reduced the overwintering eggs 29.2 per cent and that the one per cent white oil emulsion gave a reduction of 98.9 per cent. It would be desirable to have counts from a larger number of sprayed trees. However, it seems that where one tree is sprayed in an orchard heavily infested with mites the test is more severe than it would be were a block of trees sprayed.

EFFECT OF OIL SPRAY ON FOLIAGE

The foliage of the trees sprayed with 1 per cent oil in May and June were examined from time to time. The foliage on these trees appeared somewhat yellow as compared to the foliage on the trees sprayed with nicotine sulfate. No heavy dropping of leaves occurred on the trees sprayed with the oil. There was, however, a noticeable drop of young peaches on the oil sprayed trees. The per cent of fruit drop caused by the oil could not be determined as there was considerable Curculio and other injury, due to the omission of the regular spray schedule, where the oil was applied.

The four applications of 1 per cent oil applied in August on a single tree caused a light leaf fall. The older leaves appeared to be the most sensitive to the oil.

SUMMARY

Five applications of nicotine sulfate (1–800) and white oil emulsion (1%) on peaches in May and June failed to prevent the deposition of large numbers of overwintering eggs of the European Red Mite. Three applications in August of ground tobacco dust gave no reduction in the number of red mite eggs. Four applications in August of nicotine sulfate (1–800) gave a reduction of 29 per cent. One per cent white oil emulsion applied four times in August, gave a reduction of 98.9 per cent in the number of overwintering European Red Mite eggs. Some injury was caused by the oil sprays as was evidenced by a light shedding of fruit and foliage.

FURTHER STUDIES ON THE EVAPORATION OF NECTAR

By O. W. PARK, *Iowa Experiment Station, Ames, Iowa*

ABSTRACT

Further experiments by the author are in agreement with those reported a year ago, all of which indicate that nectar does not become more concentrated within the honeysac of the bee between the flower and the hive entrance, but that the observed rate of nectar concentration can be fully accounted for by evaporation in its several phases, carried on within the hive.

A year ago experiments were reported by the writer[1] tending to show that no concentration of nectar occurs within the body of the bee between the flower and the hive entrance; but that evaporation carried on within the hive is sufficient to account fully for the observed rate of nectar concentration. It was pointed out that the evaporation within the hive comprises at least three phases. (1) Evaporation from the mouthparts of the house-bee. (2) Evaporation from hanging drops placed temporarily in the roofs of cells. (3) Evaporation from the body of the cell. The importance of the first two seems apparent but so far the proportion of the total process performed by them is unknown; but valuable data have been secured on the rate of evaporation of nectar and of various sugar solutions from the body of the cell.

The preliminary experiments on evaporation from cells reported last year admitted of refinement along several lines. The cells used were of glass which might give a rate of evaporation somewhat different from cells of beeswax. This feature was easily corrected by employing sections of comb (1 x 3 inches) which had been thoroughly cleaned by the bees themselves. Each section of comb was fastened by one face to a wax-coated piece of tin (2 x 4 inches) having a hole near one end by means of which it could be hung on a nail. Those small combs were handled in such a manner that the comb itself never needed to be touched. They were weighed on chemical balances both before and after the sugar solutions were placed in the cells. Then, as before, they were placed in a wire screen cage which, when hung within the hive, exposed the solutions in the cells to the normal hive conditions of air currents, humidity and temperature, but prevented the cells from being touched by any bee. The recent experiments were conducted during a fair honeyflow and care was used to place the screen cage containing the small combs in the center of a super in which the bees were actively engaged in ripening honey at that time.

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[1] Park, O. W. Studies on the Evaporation of Nectar. Jour. Econ. Ent., 20:510–516. 1927.

In the former experiments, thin raw nectar gathered directly from the flowers was placed in the cells; whereas, when handled by the bees, the liquid freshly deposited in a cell has been largely inverted, having been in the honeysac of at least two different bees (the field-bee and the house-bee), and has been somewhat concentrated thru evaporation during its manipulation by the mouthparts of the house-bee. Since the sugars found in freshly deposited nectar are largely dextrose and levulose in nearly equal parts, and since the concentration of freshly deposited nectar varies considerably with the source, and with weather conditions; it was decided that the purpose of these studies would be well served by making up several different concentrations of solutions composed of equal parts of dextrose and levulose. This plan would yield comparative data upon solutions covering a wide range of concentrations. The sugar solutions used had concentrations of 20, 30, 40, and 60 per cent respectively.

In order to eliminate errors due to fermentation, two-tenths of one per cent of benzoate of soda was added to each sugar solution. This amount of preservative effectively prevented fermentation but was too small to change the vapor pressure of the solutions materially.

Sixteen of the small combs were used in two equal groups, A and B, which differed only in that the cells in group A were filled one-fourth full while those of B were filled three-fourths full. In each of these groups, two combs were supplied with the twenty per cent solution, so that one served as a check on the other. The combs of each identical pair were then distributed in such a way that any differences due to position within the hive would tend to be equalized. Much care was taken to see that the solution was placed properly in the cell and that all cells in a given group received approximately equal amounts.

A year ago the losses due to evaporation were determined at twenty-four-hour intervals. While this interval served its purpose in the preliminary work, it seemed desirable to make determinations at more frequent intervals in order to obtain a better idea of the changes in rate of evaporation. Accordingly weighings were made at two-hour intervals during the first eight hours, then at four-hour intervals during the daylight hours until the end of the third day, and after that at twenty-four-

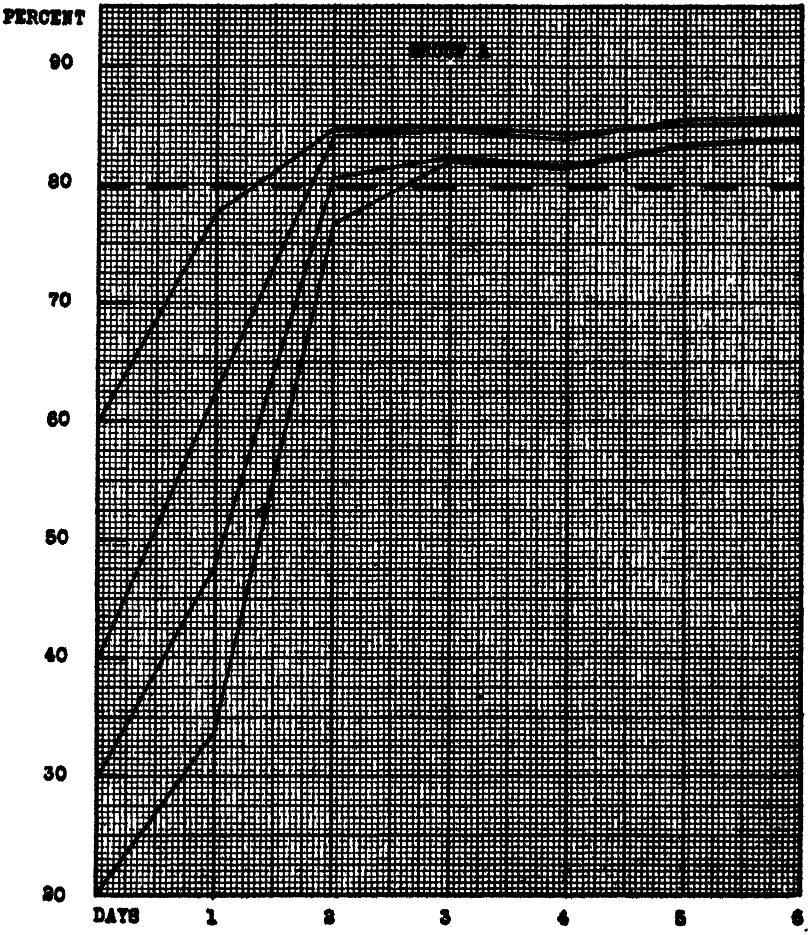

FIG. 60.—Showing rate of increase in concentration of sugar solutions in cells of honeycomb placed within the hive but screened from the bees. Cells filled one-fourth full.

hour intervals until the end of the tenth day. Throughout this discussion the term *day* is used to indicate a period of twenty-four hours, not necessarily the calendar day.

RATE OF CHANGE

Keeping in mind the fact that ripe honey has a sugar concentration of approximately 80 per cent, we may proceed to consider some of the results of the experiments (see figs. 60 and 61). In both groups, A and B, the 20 and 30 per cent solutions gained rather slowly in concentration during the first day, after which the rate increased until a concentration of approximately 40 per cent was reached. From this point, the rate remained nearly constant until a concentration of approximately 75 per cent was reached, after which the rate decreased until an approximate constant was reached somewhere between 80 and 85 per cent. In both groups the 40 and 60 per cent solutions maintained a rate of increase in concentration which was very nearly constant from the beginning until the 80 per cent mark was reached, after which the decline was rapid. In all cases, after the maximum concentration had been reached, there were fluctuations from day to day, which probably were due to changes in the humidity of the air.

As was to be expected, the rate at which concentration advanced was much greater in group A than in group B, and within each of these groups the solutions which were most concentrated to begin with were the first to reach a maximum and those which were least concentrated at the beginning were the last to reach that point. In group A the maximum was reached by the 40 and 60 per cent solutions by the end of the second day, and by the 20 and 30 per cent solutions by the end of the third day. In group B the time required to reach the maximum was somewhat more than twice that required for the respective solutions in group A.

The time required for the various solutions to reach the 80 per cent stagewas considerably less than the time required to reach the maximum, although the maximum was only a few per cent higher than the figure of 80 per cent which we use as the approximate concentration of ripe honey. In group A, the 80 per cent line was crossed by the 60 per cent solution in one and one-fourth days, by the 40 per cent in one and three-fourths days, by the 30 per cent in two days and by the 20 per cent in two and three-fourths days. In group B, the 80 per cent line was crossed by the 60 per cent solution after two and three-fourths days, by the 40 per cent after three and one-fourth days, by the 30 per cent after four and one-half days, and by the 20 per cent after five and one-fourth days. Here again it will be observed that in the case of those combs in which the cells were filled three-fouths full, the time required for the various solutions to reach the consistency of ripe honey was fully twice that required when the cells were only one-fourth full.

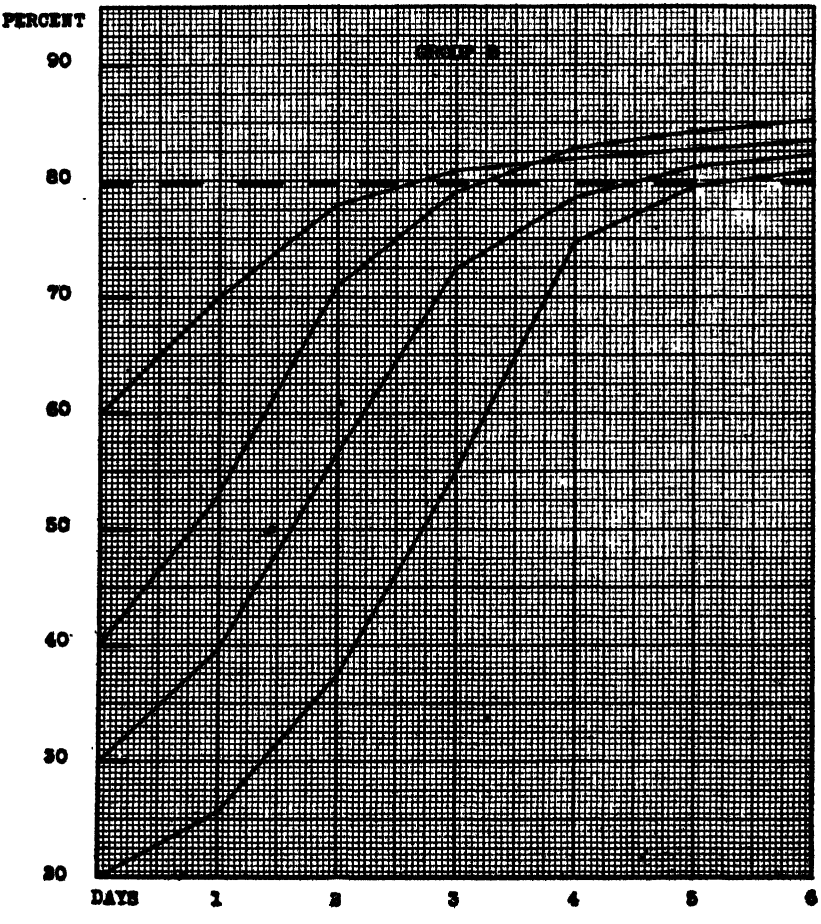

Fig. 61.—Showing rate of increase in concentration of sugar solutions in cells of honeycomb placed within the hive but screened from the bees. Cells filled three-fourths full.

It is a common observation that, so long as available room permits, bees naturally tend to spread out the newly gathered nectar, placing only a small amount in each cell, later to be gathered up and stored compactly before sealing. It is to be doubted whether bees often fill a cell more than one-fourth full of thin nectar under normal conditions, and as a rule the amount probably would be considerably less than that, with the possible exception of times of very heavy honeyflow. Then the amount used in the cells of group A in this experiment may be considered at least large enough to approximate normal conditions.

The results obtained from group A indicate that evaporation from nectar in the body of the cell takes place at a rate sufficient to advance it to the concentration of ripe honey within three days, if the initial concentration is 20 per cent or over, and within two days if the initial concentration is 30 per cent or over. (The time required for bees to ripen nectar into honey is usually considered to be about three days.) When the bees have access to the nectar, as they do under normal hive conditions, the evaporation process should be greatly accelerated over and above the rates indicated by the above determinations, due to the manipulation of the nectar by the mouthparts of the house-bee, and at times also to the hanging drops which the bees often place in the roofs of cells.

It is thus shown that evaporation within the hive, in its several phases, is adequate to account for the observed rate of nectar concentration. The results of the above experiments emphasize the fact that a large amount of comb space in the hive is a distinct advantage to the bees during the honey ripening process.

DISINFECTING COMBS

By G. L. JARVIS, *Ontario Agricultural College, Guelph*

ABSTRACT

Alcohol-formalin and water-formalin are not always effective for American foul brood in cases where there are massed spores. Treatment of brood combs may mean harboring or spreading the disease. There is no danger of infection from dry super combs. Wet super combs that do not contain scales may be disinfected by immersing in hot water for 24 hours.

The disposal of infected material, contaminated by contact with a colony of bees infected with American Foulbrood and the salvaging of equipment in a way which will tend to check the spread of the disease, rather than aid it, is a problem which has occupied the minds of not a few investigators, apiary inspectors and others interested in the welfare of the beekeeping industry.

It has been found important in this work to keep the practical application always in mind. This fact was the cause of varying the experiments in chemical solutions to a marked degree.

During the summer of 1924 and 1925 extensive experiments were carried on in the college apiaries to determine the efficiency of an alcohol-formalin solution and various strengths of water-formalin solution. These experiments were carried out with infected brood combs containing a large number of scales formed by massed spores and larval remains. In some experiments the cells containing the remains of the diseased larvae were capped and in others the cappings were removed to determine what effect the capping had on the penetration of the solution.

In 1924 alcohol-formalin and a 15 and 20% solution of commercial formalin were used as the disinfecting agents. The time of immersion varied from 24 hours in some experiments to 48 hours in others.

During this year negative results were obtained—not a single case of disease showing up in the colonies given treated combs.

In 1925 a series of experiments were carried on along the same line except that the strength of the formalin was varied to a greater degree. This year positive results were obtained in every experiment, the efficiency running from 0% to 90%. The highest percentage of efficiency was obtained from a 20% formalin-water solution where all the cells were open.

There was one serious disadvantage to be reckoned with in the treating of brood combs with any chemical solution. Ontario beekeepers were already disappointed in control measures. They were ready for eradication measures. The holding of material, so saturated with disease spores, and by this serving as a means of spread rather than control, along with the disastrous results obtained in 1925 led us to abandon further extensive experiments along this line.

Our attention in 1926 was directed toward saving the storage or super combs. As a means of spreading American Foulbrood these have always fallen in the doubtful column, and yet a well equipped apiary will likely average three boxes of these combs to one box of the more dangerous brood combs.

The object of the 1926 experiments was to discover, if possible, the danger of spread from wet super combs and find some simple method of handling these combs to remove all doubt. These combs are difficult to work with in that no visible signs of the disease are present. To overcome this, wet super combs from diseased colonies were used but to be certain that the spores were present, an inoculating syrup of an extremely high spore content was added to the small amount of honey clinging to the cell walls. All check colonies where the combs were inoculated in this manner and which received no other treatment showed signs of the disease in a very short time. However where these combs were washed with water only, 50% of the colonies showed disease, indicating a necessary mass action to start the disease. It must be remembered that when inoculated these combs carried literally millions of Bacillus larvae spores. It was not a treatment where we would expect 100% efficiency and we were surprised to see 50% give negative results. This led to the thought that a water treatment might be safe in the case of infected super combs as they would occur in nature.

The material for our 1927 experiments was more difficult to locate as we decided to use combs from naturally infected brood chambers and where the infection was in an early stage, using combs filled with honey only, in order to obtain conditions as near as possible to a badly infected super comb. Seven packages of bees were placed on these combs after they had been immersed in water only for 24 hours. The results were negative, no disease showing up during the season. This work should be carried on for at least one more season.

The results of the four years experiments would indicate·

1st. That alcohol-formalin and formalin-water solutions do not always give 100% efficiency where massed spores are concerned.

2nd. That the treating of brood combs may mean the harbouring of disease or even cause it to spread from lack of proper storage facilities.

3rd. There is no danger of infection from dry super combs.

4th. Wet super combs that have not contained brood or any super combs that "DO NOT CONTAIN SCALES" may be made safe by the simple method of immersing in water for 24 hours.

SOME TEMPERATURE RELATIONS OF *MELANOTUS* (COLEOPTERA, ELATERIDAE)

By B. B. FULTON[1], *Research Entomologist, N. C. State College*

ABSTRACT

Shade trees near sod ground have been found to be a common habitat for adult *Melanotus*. Temperature experiments show that they cannot live long on the surface of sod ground on hot days. Their choice of temperature, determined in a gradient, is much below the usual maximum temperature in open fields during summer. Negative phototropism causes the beetles to seek dark hiding places during the day. The larvae of *Melanotus* are more resistant to heat than the adults but do not voluntarily seek higher temperatures. Seasonal movements of wireworms may be closely correlated with soil temperature changes.

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[1] Contribution from the Entomology Section, Iowa Agricultural Experiment Station.

INTRODUCTION

For several years large numbers of adult click beetles, *Melanotus communis* Gyll, have been observed hiding under burlap bands kept on apple trees for codling moth records. They have also been found among debris in the crotches of the trees and under pieces of loose bark. A search around other trees revealed the fact that this is a common habit for click beetles of this species. Willow, poplar, box elder, and elm trees were found which harbored numbers of the beetles in cavities of the trunk, under slabs of loose bark, under debris in the crotch, or in soil cracks around the trunk. Trees in the vicinity of prairies or old pastures yielded the greatest numbers. By leaving a burlap band on a tree for a few days at least a few beetles could be obtained in most localities, even when none were found present at the time the band was applied. Beetles were found abundant about trees in May, June and July. In August they became scarce.

The presence of the click beetles in such localities was puzzling and at first the writer suspected that they were there in search of food. Observations at night on old apple trees revealed the beetles running actively about on the trunk and branches of the trees but none were seen feeding on any part of the tree. Baits of diluted molasses or honey attracted large numbers at night and they fed on the sweetened fluid eagerly.

TEMPERATURE EXPERIMENTS WITH ADULTS

In an effort to shed further light on the problem the writer tried removing beetles from their hiding places during the day and subjecting them to the surrounding environment. Click beetles were taken from a large poplar tree standing in a pasture. One was placed out in the partly dry grass in the sunlight. The beetle struggled wildly and pushed its way under some dead grass blades where it remained. On removing it after a few minutes it was found to be dead. Another was placed on bare ground in the sunlight. In one and a quarter minutes it was on its back and had ceased to struggle. After a total exposure of one and a half minutes it was placed in a bottle in the shade to see if it would recover but it did not. The maximum temperature recorded for the day was 92° F. in the shade.

After further experiments with the beetles on other days it became evident that they could not stand the heat that developed on sod ground. Even on much cooler days they became very uncomfortable. If placed in the shade of a tree they would crawl toward it. If I stood within three or four feet of a beetle it would crawl directly toward me and change its direction as I moved to one side or the other. Usually a beetle placed on the ground would first climb some plant and attempt to fly. If the temperature was very high this seemed to be impossible. Its movements would be so violent that it would fall before gaining the top of the plant. Failing in that it would seek shade on the ground and if it succeeded in digging under a mat of grass it might live for several hours even on a hot day. Usually a beetle would continue to wander about until killed by the heat.

When the temperature in the shade was 90°F, some of the beetles were able to fly. At still lower temperatures flight appeared less difficult. The flight is so rapid that I could not follow their course. One flew directly toward me twice. Two others headed toward nearby buildings. Probably they were attracted by dark objects when flying as well as when crawling.

Some further experiments were tried to find out more accurately what temperatures would kill the beetles. One beetle, dropped on the ground in the sunlight, died in three minutes. The temperature at that point was 49°C. while the air temperature in the shade was 36°C. At 45°C. in an oven a beetle died after 25 minutes exposure. At 46°C. a beetle was apparently dead after six minutes, but later partly recovered from the experience. Five minutes exposure to 46½°C. and 3½ minutes exposure to 49°C. in the oven caused death. When we consider that a temperature of 53°C. may be developed on the surface of partly dry sod ground when the air temperature in the shade is only 32°C. (90°F.) it is not surprising that the beetles do not linger there long during the day.

In order to determine what temperature the click beetles would select if given a choice, a crude temperature gradient was constructed. A rectangular trough about six inches square and three feet long, containing a few inches of wet sand, was packed in ice for a few inches at one end, while the opposite end was placed over the open end of a box containing two 40-watt electric lights. The wet sand conducted the heat sufficiently to form a temperature gradient along the entire length altho the changes were greater near the ends. Ten click beetles were placed in a glass tube nearly as long as the trough and large enough for them to turn in readily. Both ends were closed by large test tubes that fitted over the tube. The tube was placed in a trench in the sand bath leaving only enough on the top side exposed to permit observation of the beetles. Thermometers were pushed into the sand a few inches apart, and in a slanting direction so that the bulbs were partly under the tube and in contact with it. By leaving these in place constantly during the experiment the temperature could be closely estimated for any part of the tube where beetles were resting. The temperature of the cold end varied during the course of the experiment from 9°C. to 13°C. while the hot end varied between 40° and 50°. The changes occurred slowly so that the beetles had ample time to react to them.

When the experiment was first started most of the beetles had a tendency to remain at the cold end. The ends of the tube were close to ends of the trough and somewhat darker on that account. While the beetles could not tolerate the hot end they apparently found the low temperature at the other end less disturbing than the light. To equalize the light factor one inch strips of wood were placed across the tube five inches apart. The beetles did not settle down in any place permanently but moved about from time to time.

Results were taken with three different sets of beetles and are tabulated below. With the third lot of beetles, the wooden bars were removed and the first reading (No. 6) shows that the beetles again lingered in the shaded cold end of the tube. For the last three readings the bars were left off and the trough was covered between observation so that it was almost entirely dark. The totals show that 57% of the recorded resting points for the beetles came within the narrow range of 26° to 29°C.

Some additional evidence on the temperature preference of the beetles was obtained by watching the moving beetles. When a beetle started moving along the tube it would either stop at some point or continue toward the end until it encountered unfavorable temperature which would cause it to turn around. Some would continue slowly to the cold end of the tube but none ventured far in to the warm end. A number of records were taken of the temperature at points where the beetles turned. At the cold end of the tube these were as follows; in degrees C.: 10° (end), 13° (end), 15°, 16½°, five at 18°, 19°, two at 20°, three at 21°, and one at 22°. Beetles moving toward the warm end usually slowed down rather suddenly at about 30°C. and began moving from side to side and finally turned. Temperatures recorded at turning points were 30°, 32°, 33°, 36°, 37°, 38°.

EXPERIMENTS WITH MELANOTUS LARVAE

The larvae of *Melanotus communis* were subjected to similar experiments to determine their optimum and maximum temperatures. The same temperature gradient was used with the exception that a smaller tube was used and that it contained a thin uniform layer of moist sand. Ten wireworms were placed in the tube, five at each end. Those at the warm end left quickly except one that persisted for some time in trying

TABLE 1. SHOWING POSITION OF CLICK BEETLES AT REST IN A TEMPERATURE GRADIENT

Reading	Lot	Length of Confinement	Beetles at rest. Temperature °C.																			
			13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	I	1¾ hr.							3					1				7				
2	II	½ hr.										2	1				5					1
3	II	1 hr.											2	2		3						
4	II	1¾ hr.										1	2		1	1	3					
5	II	2 hr.								4			1						5			
6	III	1 hr.	5														3				1	
7	III	6 hr.																7				
8	III	6½ hr.									2							5			1	
9	III	18 hr.				1		1		1						4	2					
	Totals		5			1		1	3	5	2	3	6	3	1	8	13	19	5		2	1

to bore thru the vial that closed the end of the tube. The temperatures where wireworms could be seen without opening the tube are recorded in the table below. The tube was kept in nearly complete darkness during the experiment.

TABLE 2. SHOWING POSITION OF WIREWORMS IN A TEMPERATURE GRADIENT

Length of	Position of Wireworms in Gradient. Degrees C.																				
Confinement	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1 hr......	3*				1								2	1	1	1	1				
6 hr......					5*			1			2	1									
6½......						2		1		1	3	1	1								
18.......	1*				2		1						1		2	3					
18½.. ..	2*				1	1	1		2												1
Totals....	6				9	3	2	2	2	1	5	2	4	1	3	4	1				1

*End of the tube.

Data on the maximum temperatures for the wireworms was obtained by means of a Freas water thermostat. Test tubes were suspended in the water bath, weighted down by small pieces of lead, and the openings covered with small pieces of celluloid. The temperature was taken with an accurate thermometer inside of one of the tubes. After the temperature had become stabilized the wireworms were dropped into the other tubes and subjected to the heat for various periods of time. After removal they were placed in large vials on moist sand; the vials were loosely corked, labeled and left at room temperature for a day to permit recovery of the wireworms, if the exposure had not been long enough to kill.

The larvae were considerably more resistant to heat than the adults. The results of the experiments, are shown in Fig. 62, except the data given below for two lower temperatures. When plotted on cross section paper it became evident that the killing points for the various temperatures were arranged in a curve having the form of a hyperbola. It was found that the points above 47°C. fitted very closely to a mathematical curve, any point of which could be computed by the equation,[2] $T = \frac{D}{4.21D - 196.59}$ (T = time, D = temperature). Below 47½°C. there is an increasing divergence between the experimental data and the computed points on the curve. The curve would never reach the line for 46½° C. altho at that temperature it was possible to kill the larvae by an exposure of 32 minutes. At 44.6°C, larvae survived an exposure of 150 minutes but were killed by 225 minutes exposure. It is entirely possible that the prolonged exposure at the lower range of temperatures causes death by dehydration or in some different way than the shorter exposures at the higher range of temperatures.

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[2] Computed by Prof. A. E. Brandt, Mathematical Statistics Dept., Iowa State College.

DISCUSSION OF RESULTS

The experiments with the adult *Melanotus communis* explain some habits which at first seem to have no significance in their life history. The beetles are sensitive to high temperatures and negatively phototropic. Their optimum temperature range is from 20° and 30°C. with a theoretical optimum as indicated by their selection of temperature in a gradient, at about 27° or 28°C. Above 30°C. the heat becomes increasingly intolerable to them, and they make violent efforts to escape it. Below 20°C. the temperature does not influence their movements so strongly and a slight decrease in light will induce them to enter colder situations.

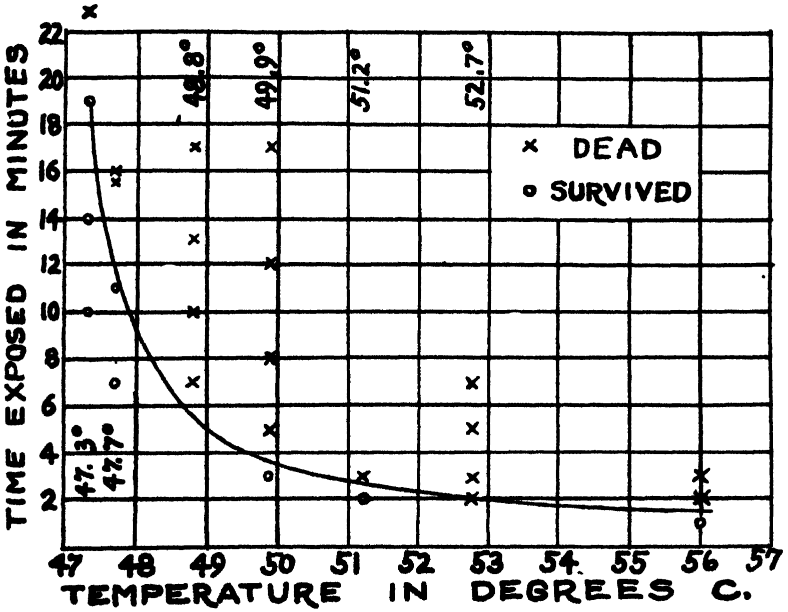

FIG. 62.—Results of exposure of wireworms to killing temperatures for various lengths of time. The curve was computed to fit the experimental data.

The beetles carry on their natural activities at night. Both reduced light and lower temperatures probably induce greater activity. Altho not checked on by direct observation it is probable that the beetles leave the trees where they find shelter during the day and fly to fields for oviposition. With the increase of light and heat in the morning the beetles, guided by the sense of sight, fly toward dark objects and thus find their way back to the tree trunks where they enter the coolest and darkest situations.

The larvae of *Melanotus communis* are more resistant to heat than the adults but judging by the rather limited evidence in the temperature gradient experiment they do not select higher temperatures than the adults. Only one moved voluntarily into a temperature higher than 29°C. The wireworms used in the experiment showed no marked preference for any limited temperature range between 17° and 29°C. The rather large number recorded at 13°C. was probably due to the fact that those were in the end of the tube. They sometimes persisted in trying to bore into the end of the tube in an effort to completely surround themselves with soil. The wireworms were continually moving during the experiment and seemed constantly disturbed by the fact that they could not get entirely under the sand. If apparatus can be devised to permit submergence in soil and not make the recording of data too difficult a more accurate determination of the optimum temperature may be possible.

It is known that wireworms become less destructive in midsummer on account of working deeper into the soil at that time. In the spring and early summer they are found in the upper soil layers or even above the soil in manure of cattle and horses in pastures. Data from these experiments is not sufficient to explain fully the influence of temperature on the seasonal movement of wireworms. No doubt soil moisture is an equal or greater factor in determining seasonal migrations. However if we assume an optimum of about 21°C. which is the average of all the records shown in the table, it would correlate closely with what is known of wireworm movements. According to data taken by Bouyoucos (1) in Michigan the temperature of loam soil gets above 21°C. in the upper six inches in July and August. In April, May and June the temperature of the upper two inches of soil are closest to 21°C. while the lower levels are cooler. This would be expected to attract the wireworms upward. In September or October the temperature gradient of the soil is reversed so that the higher temperatures are below and this condition remains until March. During these months then we would expect to find the wireworms deep in the soil. On this point we have little positive evidence. Excavations of three feet in depth failed to reveal a single wireworm on October 25, 1927, in a piece of sod where wireworms of various ages were unusually abundant in the upper layers during the early summer. In Kansas, McCulloch, Hayes and Bryson (2) found wireworms of several species, during two winters, at average depths of 7.7 inches and 10.1 inches.

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WATER CONSERVATION IN INSECTS[1]

By WILLIAM ROBINSON, *Division of Entomology, University of Minnesota*

ABSTRACT

Insects which live on food low in water have the capacity, like the cactus, of holding much of their water in the bound or colloidal condition. In this form the water is held firmly against the force of desiccation. This capacity varies inversely as the total water content of the insect.

Since the greatest part of living tissue is water, it follows that this constituent is an exceedingly important one in the life of the individual. Water is everywhere present in the organs, tissues, cells and protoplasm. It dissolves the food so that it can be digested and pass through into the circulation. It is the medium by which the nutrients are distributed throughout the body to the points of oxidation. It is the great carrier of the poisonous waste products to the outside; and it permits and largely facilitates the vital processes of the organs. This single factor of water, therefore, exercises a profound and far-reaching effect upon the organism. A large and constant supply is necessary, and unless it is maintained within certain limits life will cease. In general, life can be maintained longer without food than without water.

In insects, the amount of water present ranges from fifty to ninety per cent of the total weight, depending upon their habits and the nature of their food. The food differs greatly in its water content, from less than ten to as high as ninety-five per cent. Those species which feed upon succulent tissue have an abundant source of supply, and the matter of conserving the water is of little importance to them; rather the problem of such insects is the elimination of excess moisture. This is true, of course, only so long as the food remains succulent; however, it is known that with a decrease in the per cent of water, as when the food wilts, these insects quickly perish. There is another group which lives upon

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[1] Published with the approval of the Director as Paper No. 746 of the Journal Series of the Minnesota Agricultural Experiment Station.

stored or air-dried materials containing as low as eight per cent water. With them the conservation of their water is of vital importance.

All living organisms receive water from their metabolic processes. This is formed as a byproduct of metabolism and in most cases it makes up only a small part of the total water received, the greater part being taken up in drinking and with the food. However, with those species of insects which live upon dry food this is the largest and most important source of supply and without it they could not exist.

The cactus is a classical example of a plant which is able to conserve its water content in a remarkably efficient manner. Not only is it able to exist under desert conditions of very low rainfall and great evaporation, but it is actually able to build up and hold a large amount of water in its tissues. It is not accomplished by osmotic pressure, for this is low in such plants. The mechanism with which the cactus holds the water in its tissues is by the adsorption of water on the surface of its colloids. The cells of all living tissue, both plant and animal, contain countless millions of minute colloidal bodies which attract and bind water as a film on their surfaces. The water thus bound is held by the colloidal particles with a force which is astounding in biology.[2]

The possibility that this phenomenon characteristic of the cactus could be found also in insects occurred to the writer when working with the Granary Weevil, *Sitophilus granarius*. This species can live in stored wheat having a moisture content as low as nine per cent, and it has access to external water in no other way. This provided an example among animals somewhat analogous to that of the cactus among plants. It then remained to determine what proportion of the total water of the grain weevils was in the free and in the bound form. Numerous tests were made and it was discovered that fifty per cent of the water was bound and held by the colloids in this condition.

Several species of insects which live on foods differing widely in their water content were then obtained, and a series of experiments was conducted to determine if the general phenomenon could be found among insects of water binding in an inverse proportion to the amount of water available in the food. That is, if on the one hand those species which live on food low in water and thus have the need to hold on to their supply would bind a large amount; and if on the other hand those which feed on succulent tissues with a large amount of water available, presenting no need for a mechanism to conserve the supply, would bind a proportionately small amount. The species used are listed in Table 1.

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[2] For a more detailed discussion of this statement the reader is referred to a paper by the author entitled "Relation of hydrophilic colloids to winter hardiness of insects" published in the Fifth Colloid Symposium Monograph. A reprint will be sent upon request.

TABLE 1. LIST OF SPECIES USED IN BOUND WATER TESTS

Species	Food Plant	Water Content of Food %	Water Content of Insects %
Granary Weevil, adult (*Sitophilus granarius*)	Stored Wheat	9–11	46–47
Rice Weevil, adult (*Sitophilus oryza*)	Stored Wheat	15–16	48–50
Locust Borer, adult (*Cyllene robiniae*)	Locust tree trunk	30–32	56–60
Colorado Potato Beetle, adult (*Leptinotarsa decemlineata*)	Potato plant, leaves and stem	70–74	62–66
White grub, larva (*Phyllophaga* spp.)	Wheat shoots and roots	64–67	73–82
Mourning Cloak, larva (*Vanessa antiopa*)	Willow leaves	70–73	77–79
Willow Sawfly, larva (*Cimbex americana*)	Willow leaves	70–73	79–82
Cutworm, larva (*Chorizagrotis auxiliaris*)	Lettuce	78–79	83–88
Army Worm, larva (*Cirphis unipuncta*)	Corn leaves and stem	77–78	87–89
Imported Cabbage Worm (*Pontia rapae*)	Cabbage	88–89	83–84
Polyphemus-moth, larva (*Telea polyphemus*)	Hazel leaves	71–73	90–92

These insects were taken directly from their food and determinations made of the total, free and bound water content. From these tests it will be seen that the abundance of water present in the food affects the total water content of the insect's tissue, Fig. 63. Those species shown in the lower part of the chart which are able to exist upon food very low in water, have themselves a low water content; whereas the remainder which require a large per cent of water have a noticeably increased amount. The relation between total water of the food and that of the insect takes the form of a straight line. This is the full black line, the lower of the two lines shown in Fig. 63. It represents the relations between water content of the food and that of the insect, as these relations actually exist.

It will be noticed that most of the cases fall on or near this line. The upper or broken line represents a hypothetical condition in which the water content of the insect would be the same as that of its food. None of the cases fall on this line and only two or three occur in its vicinity. This shows that other factors come in to affect the total water content of the insect, and *the degree of the deviation from the broken line indicates the extent of the influence of these other factors.*

All the cases on the lower side of the broken line indicate that the water content of the insects is greater than that of the food. Also, the less the per cent of water in the food the greater is the divergence, which means that a correspondingly large amount is received from another source. This other source has already been mentioned, namely, the water of metabolism. Upon looking at the chart in Fig. 63 it is not difficult to realize the importance of metabolic water in the physiology of some species. It would probably be impossible for some species to exist if dependent entirely upon the scanty amount of water obtainable from their food.

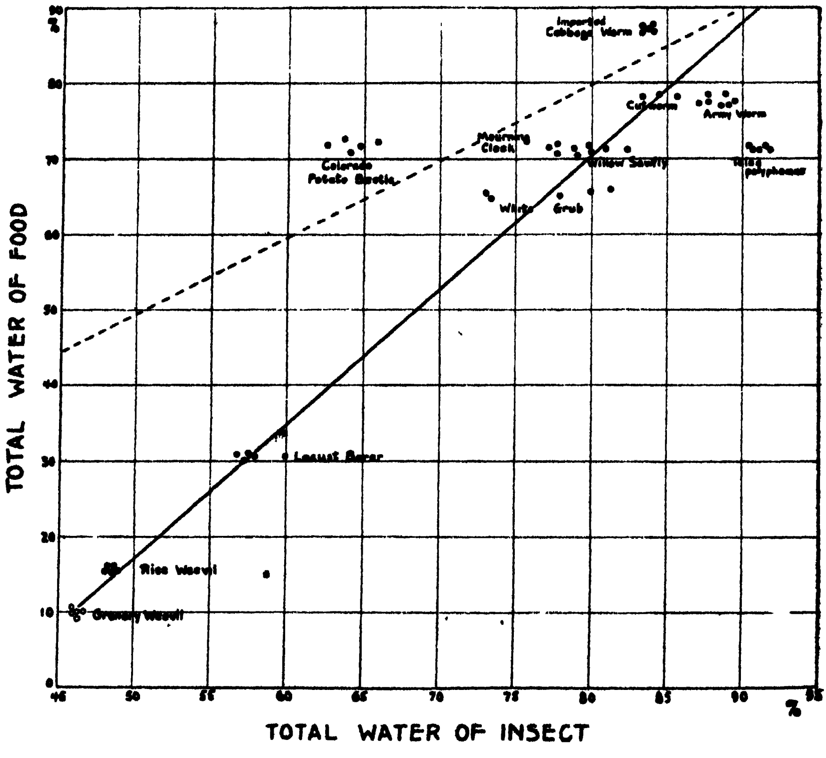

FIG. 63.—Relationship between water content of insects and their food.

Water of metabolism is thus an important factor in affecting the total water content of the individual. Another factor, which is itself made up of a number of factors, is the general physiology of the species. After grouping all sources of water, and taking into consideration the demands of the insect's physiology such as water requirement and elimination, we then have as a resultant for this study the total water content of the individual.

The water binding capacity of the different species is shown in Fig. 64 where a correlation has been made between the total water of the individdual and the amount held in the bound condition by colloids. Those species which live on comparatively dry food and have a small percentage of water in their own tissues, hold a large per cent of it in the bound form, where it is secure against the forces of desiccation. For instance, the Granary Weevil which has only forty-six per cent total water has fifty per cent of this in the bound condition. The Rice Weevil, with slightly more total water, namely forty-eight per cent has a smaller proportion or thirty-five per cent of it bound; and the Locust Borer, with fifty-eight per cent total water binds twenty per cent.

At the other end of the chart are species which live on food high in water and which consequently have a high content themselves. A reverse order of conditions occurs here. Having a large amount of water in their tissues, namely from fifty-eight to ninety-two per cent, they have a very small amount of it bound. This amount runs from nine to as low as three per cent respectively.

These preliminary tests indicate therefore, that the remarkable property of the cactus, among plants, of retaining its water supply against desiccation by colloidally binding a large proportion of it, is found also in the animal kingdom with some species of insects which live under low mositure conditions and to which the conserving of their water supply is of vital importance.

SUMMARY

The role of water in the physiology of insects is discussed briefly. The range in the total water content of insects and of their food is given, and the value of metabolic water as a source of supply is mentioned. A brief statement is made of the mechanism with which the cactus conserves its water supply; and some experiments are described in which it has been demonstrated that this same capacity is possessed by some insects which live under low moisture conditions.

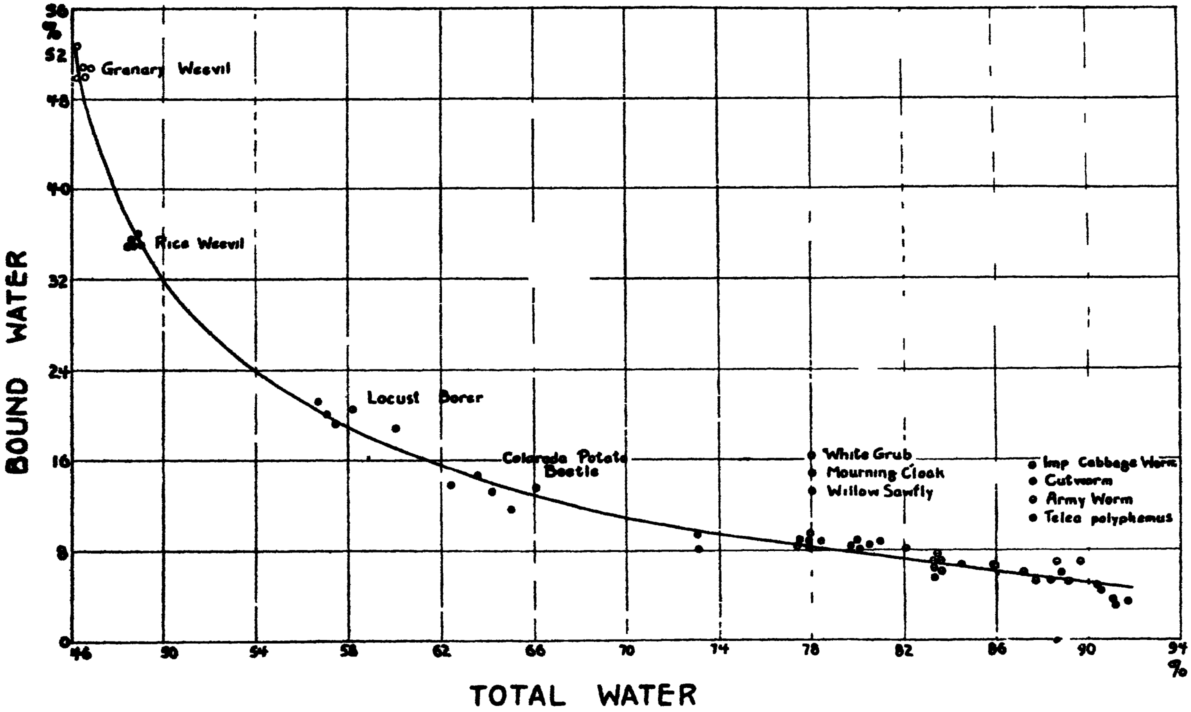

FIG. 64.—Relationship between water content of insects and the per cent of it which is bound by colloids.

RESPONSES OF INSECTS TO SMELL AND TASTE AND THEIR VALUE IN CONTROL

By N. E. McIndoo, *Senior Entomologist, Deciduous-Fruit Insect Investigations, U. S. Bureau of Entomology*

Abstract

Since the literature on this subject is widely scattered and has never been collected and reviewed, the following brief summary will be of interest to many entomologists. This information was gleaned from hundreds of references, but only 51 of them are cited here.

The perfume industry is the most important practical application of smell, and the writer ventures to say that economic entomology is its second most important one. Few people realize the importance which smell and taste play in helping to control insects. The information gained while using attractive baits and repellents to control insects has come about in a haphazard way by the trial-and-error method, the most laborious and expensive procedure of all. We should no longer be compelled to use this method, but since no definite rules have been established there seems to be no other way of attacking problems dealing with the senses depending upon chemical properties. The likes and dislikes of insects in regard to attractive and repellent odors are so different from our own that a person's sensations can not be used as a guide.

Uses of Smell in Beekeeping

Smell seems to be the chief factor on which the social life of a colony of bees is founded, and it is the one used by the beekeeper in controlling them. Smoke is an indispensable means of controlling bees, but it might be argued that smoke is an irritant and does not necessarily control bees by affecting their smelling organs. This question is debatable, although they can detect smaller quantities of smoke than can a person, and a small amount does not irritate us. Other facts concerning smell in beekeeping are as follows: A new hive odor is formed in uniting colonies. The foreign hive odor is eliminated in introducing queens. Bee odors help in catching swarms. And the queen odor helps us to tell whether or not a colony is queenless and aids in locating queens.

Attractive Baits and Attractants

In regard to attractive baits smell and taste are both used, although the writer believes that insects do not have a true sense of taste. Relative to odorous materials used in controlling insects there are two kinds—attrahents, usually called "attractants," and repellents (not *repellants*).

Poisoned attractive baits were first tried against grasshoppers in 1885 in California by Coquillett. After having prepared a food which grasshoppers like better than their natural one, the next problem was to improve it in every way possible—particularly in regard to its cheapness and attractiveness. The next important step was made by Dean (9) who used oranges or lemons as an attractant. The next important step was made by Parker (31) who substituted amyl acetate or banana oil for the oranges or lemons in the bait. Let us cite one example of recent grasshopper campaigns to show the immense quantities of poisoned bait used and the millions of dollars saved by its application. In 1921 war was declared against these insects in western Canada and the campaign was organized on a semi-military basis. In Saskatchewan the supplies furnished to the municipality amounted to 2,720 tons of bran, 225 tons of sawdust, 112,636 gallons of molasses, 2,805 cases of lemons, 166 tons of arsenic, 34 tons of Paris green, and one barrel of amyl acetate. The campaign in this province alone is estimated to have saved 1,400,000 acres of crops.

Attractive poisoned bran baits are also used as control measures against armyworms, cutworms, crickets, and earwigs, thus saving the farmers and others millions of dollars.

Poisoned baits for ants were seldom recommended and little improvement in their attractiveness was obtained before 1909, in which year control measures were first suggested against the Argentine ant. Entomologists finally prepared a satisfactory bait which now is generally recommended as a remedy against all noxious ants. It consists of 11 pints of water, 7 grams of tartaric acid, 9 grams of benzoate of soda, 12 pounds of granulated sugar, 2 pounds of strained honey, and 3/4 ounce of sodium arsenite. Great care must be exercised in preparing this bait, and also particular attention must be paid to the cleanliness of the vessels used, for if the bait accidentally becomes flavored with any undesirable substance it will be unattended by the ants (50).

The struggle against the olive fly has been a long and hard contest and no progress was made against it till sweet poisoned foods were used. It seems that all the countries troubled with this pest are now using the spray method and that only a part of each olive tree is sprayed. The spray used consists of 90 gallons of water, 100 pounds of molasses, and 2.5 or 3 pounds of sodium arsenite.

Other fruit flies, including the Mediterranean fruit fly and melon fly, are partly controlled by attractive baits or sprays.

Fly-poison preparations, many of which contain arsenic, are now common on the market. A weak solution of formalin is at present more generally used instead of arsenic. More recently, however, the U. S. Public Health Service has recommended a 1 per cent solution of sodium salicylate, which, when added to milk or sugar sirup is considered almost equally as effective.

After the advent of the fly-trap the idea was to develop an attractive bait so powerful that it would attract flies from long distances. A mixture consisting of 2 gallons of cheap molasses, 1 pound of sodium arsenite, and 10 gallons of water has recently been sprayed on trees and other objects with good results. A mixture consisting of 5 per cent sugar, 12 per cent of glycerine, 1 per cent of sodium arsenite, and water proved successful against flies during the Egyptian campaign of the late war. Maxwell-Lefroy (28) claimed that at last he had found the ideal bait which filled his bottle-traps full of flies. It consists of casein, brown sugar, and water, mixed in equal parts. This mixture must stand for at least 24 hours before flies pay much attention to it. In Egypt the thousands of flies attracted from a neighboring village by the strong odor of butyl acetate afforded an example of chemotropism on a very large scale.

Experiments caused Richardson (34, 35) to conclude: First, that house flies, are attracted to fermenting organic substances largely by the odor of ammonia, a product of this fermentation; second, that ammonia attracts a preponderance of females; and third, that when butyric and valerianic acids are added to the ammoniated substance the egg-laying response of the house fly is increased. Crumb and Lyon (8) concluded that carbon dioxide induces the house fly to lay eggs in fermenting substances, but that ammonia does not possess this attracting influence. They remark that the apparent discrepancy between their results and those of Richardson is merely a question of interpreting results, because they believe that eggs were laid only where carbon dioxide was being liberated, and that the female house fly is attracted for egg-laying by decaying organic matter in proportion to the vapors of carbonic and acetic acids liberated in the fermentation processes. In another paper Richardson (36) answered the criticisms of Crumb and Lyon by repeating his experiments with their nidus, bran. He confirmed his former results, but did not observe that carbon dioxide attracted the house fly to its natural environment. After making a study of the chemotropic reactions of 19 species of flies to fermenting and putrefying substances, Roubaud and Veillon (39) point out that the problem is a more complex one than has been generally supposed. Not only do the reactions of different species differ, but also they differ between sexes of the same species. These authors state that neither carbonic acid gas nor water vapor is sufficient to attract flies, therefore, these can not be the determining factor in nature. The attraction evidently consists of a complex mixture of gaseous emanations which are produced at a certain stage of decomposition.

Speyer (43) tested a large list of chemicals as attractants for the house fly and certain other insects. He gives a good theoretical discussion of the subject to which the serious student is referred. He believes that there is no relation between volatility of an attractive substance and the response of insects to it. The most recent paper on this subject, and one extremely interesting to the specialist, is by Cook (5) in 1926. His experiments were planned to determine the relations between the physical properties of the various compounds and their attractiveness to flies.

As early as 1896 baited traps were used by collectors for catching a harvest of fertilized, egg-laying female moths. For night-flying moths a mixture of stale beer or rum and brown sugar is used. An efficient bait for Hymenoptera consists of stale beer, brown sugar, and apricot juice. The second oldest application of smell plays, or did play, a very important role in the wine industry of Europe. This pertains to the trapping of the grapevine moths. Since 1910 strenuous efforts have been made to discover the most attractive baits obtainable, but now this method is supplanted by the application of insecticides. An early bait consisted of equal parts of sugar water, stale beer, and old cider. Later, wine or dregs of wine, called lees, became the chief odorous constituent of the various baits compounded. Alcoholic fermentation must be present in the bait if moths are to be attracted. Another bait consisted of molasses, water, and wine lees, which variously compounded seems to have been the most popular one used in several European countries; but later when this method was used only as an indicator, it appears that nothing more than molasses mixed with water served as an attractant.

Molasses, put in small troughs, was allowed to ferment and the odors emitted attracted large numbers of cutworm moths in Russia in 1913 and 1914. The total number of moths caught in 21 troughs was 860,843, which might have produced 77,500,000 cutworms. The same method has recently been tried in Canada against cutworm moths, but has not proved successful.

A molasses-yeast bait was placed by Peterson (32) in a peach orchard in New Jersey, and it was observed that large numbers of the peach moth came to the bait pans. This observation was a stimulus for more extended work with attractive agents, but this particular bait when fermenting proved to be the most attractive one tested. Frost (13) used weak acids, volatile oils or their constituents, sugars, and molasses as attractants. The fermenting sugar baits attracted the most peach moths. Peterson (33) tested about 250 aromatic chemicals as possible attractants for the peach moth. Terpineol and several essential oils were somewhat attractive, but much less than were several fermenting sugar-producing products. Fermenting fruits (dried fruit in water), particularly prunes, pears, and apricots, attracted large numbers of moths. Using dried fruits, sugars, and sirups in Maryland peach orchards in 1926, Siegler and Brown obtained results similar to those of Peterson. Apricots were the most attractive of the dried fruits used.

Supposing that the codling moth is attracted to fruit trees by odors, Yetter (51) conducted a large series of experiments in Colorado by using 35 aromatic chemicals. Of these only 5 attracted moths in sufficient numbers to give promising results. These 5 are isobutyl-phenyl acetate, diphenyl oxide, bromo styrol, benzyl benzoate, and safrol. He firmly believes that, if this method were systematically carried out by all the growers in the Grand Valley and for the entire season, much could be accomplished in checking the damage done by this pest.

The most promising and clear cut example of how a definite chemical constituent can allure myriads of insects to their doom is had by feeding attractive baits, scented with geraniol to Japanese beetles, as demonstrated by Richmond (37) at Riverton, New Jersey. For 20 years or more much has been done to develop a remedy for the strawberry root weevil, but not until recently has a satisfactory control measure been discovered. An attractive bait has at last been developed by Forsell. It is claimed that the discovery and perfection of this poisoned bait marks an important horticultural step in the fruit industry of the state of Washington, because this weevil had become so serious in many places that the strawberry-growing industry seemed doomed (29).

A brief discussion of attractants and repellents is given by Wardle and Buckle (47).

CHEMOTROPISM

The entire subject of attracting and repelling by chemical agents is called chemotropism, but in regard to animals it should really be termed *chemotaxis*, leaving the word chemotropism to express the responses of plants to chemical agents. Attractants induce positive chemotropism and repellents negative chemotropism. Trägardh (44) says: "By the term 'chemotropism' is meant, as well known, the automatic orientation of the animals to any olfactory sensation in such a manner that both sides of the body are struck by the lines of diffusion at the same angle.

Theoretically, when a substance diffuses an odour, fine particles are ejected in straight lines, but in reality the air currents cause the lines to deviate from their straight track."

The first investigator to apply chemotropism in economic entomology was Verschaffelt (46) of Holland, who experimented with cabbage worms in 1910. He believes that they seek out various mustard oils as well as the various glucosides derived from them, and that in nature the whole group of mustard oils attracts them to their host plants, including the cabbage plant and other related crucifers.

The first writer to emphasize a serious study of chemotropism as well as all other tropisms for the purpose of discovering new weapons for fighting noxious insects was Dewitz (10) of Germany in 1912.

The first economic entomologist to apply chemotropism, as such, in control measures was an Englishman, the late F. M. Howlett (18) in 1912. For several years before his death he was the recognized leader in this line of research and his publications served as a strong stiumulus to encourage other work along similar lines. His location at Pusa, India, was peculiarly favorable for chemotropic experimentation, and his pioneer work has blazed the trail for many others. He imagined that the sense of smell in insects has been developed only in certain directions, and that these animals are extremely sensitive to the odor of certain substances, while other odors do not make any impression on them. In other words, we may assume that every species is adapted merely to react to the odor of certain organic substances which under normal conditions play a part in their life. Consequently, there should exist a certain correlation between food specialization and the sense of smell.

Up to 1913 Trägardh (44) of Sweden tells us that the importance of chemotropism has not been sufficiently emphasized; therefore, he lays great stress on this new line of endeavor, hoping that in the near future new weapons of warfare will be discovered for combating our insect enemies.

After pointing out what an abundant field exists for physiological research as regards chemotropism, Imms (20) of England in 1914 remarks that it is a line of work which is likely to achieve important practical results that might be applied, in many instances, at no great cost of labor or outlay of money.

Chemotropism, says the late C. G. Hewitt (16) of Canada in 1917, is the reaction to stimuli of a chemical nature perceived through the olfactory sense. Since odor is undoubtedly the most important factor in the environment of insects, the importance of this tropism is evident.

Sen (40) of India in 1918 says that nowhere in the animal world is there a more restricted choice of food for certain caterpillars. Therefore, he considers it very natural to enquire: What is it in a particular food that exercises such a strong attraction to a given species of insect?

McIndoo (24) in 1919 also stressed the importance of this line of research for the sake of finding attractive baits in order to help control some of our insect enemies.

The importance of chemotropism in economic entomology was stressed by Treherne (45) of Canada in 1922. He says: "There seems little doubt that, in general, insects are attracted to their food plants, hosts or habitat by positive chemical stimuli, and repelled by negative chemical stimuli and their actions in their habitat are governed by a complex of stimuli which while they can be expressed are not fully understood. * * * We have not properly considered the reaction of these stimuli upon the sensory organs of insects and it is this field that awaits study."

Among the higher animals chemotropism is extremely important, yet the writers seldom or never use this term when an animal tracks its prey by scent, or when baits are used. When catnip oil is exposed in a backyard, it will in time attract nearly all the cats in the neighborhood. Dogs, instead of becoming infatuated with catnip odor, delight in smelling the stinking goosefoot. The Biological Survey uses catnip oil to lure stray house cats to traps where they are easily caught and killed. Tests showed that this oil works like a magnet in attracting all the cat species in the western states (30).

How insects select places for egg-laying is discussed by Richardson (35).

Insect pests, says Howlett (19), in all probability find their food plants entirely or almost entirely by the smell of the whole plant or of some particular part of it. It will often be necessary to appeal to the chemist for information as to the substance responsible for the attraction in such cases, but when a knowledge of these substances is obtained it will constitute an important aid in the warfare carried on by the economic entomologist.

Brues (2) says that there is much in the behavior of certain insects to suggest that food plants are selected by the parent female on the basis of odor and also accepted on the same basis by the larvae.

Lutz (23) admits that our ignorance of floral odors and the olfactory sense of insects is practically complete, and warns us not to make the mistake of assuming that only those things which man perceives need be considered when testing insects and odors.

Using an insect olfactometer McIndoo (25-27) gives indisputable proof for the first time that plants (not flowers) attract insects by the odors emitted.

REPELLENTS

Repellents usually have only temporary effects of short duration in keeping the harmful insects a short distance from the bodies of persons and domestic animals or from cultivated plants. A few repellents under certain conditions, however, may be effective for long periods

Smoke has been referred to as a repellent to control honeybees, and it is an effective one against mosquitoes and biting flies Many of the substances used as repellents emit poisonous exhalations. It is questionable in these cases whether it is primarily through the action of the olfactory sense that the insects are driven away. In other words, it is not known whether the repellent effect is caused by the stimulation of the smelling organs by these exhalations or whether the insects are injured by the passage of the exhalations into the breathing pores. Poisonous repellents include coal tar and petroleum and many of their derivatives, such as napthalene, carbolic acid, kerosene, etc In other cases the olfactory sense is certainly the primary factor to be considered.

People long ago searched drugstores for mosquito repellents and among the first ones tried were camphor and certain essential oils By 1900 a large list of aromatics were being used as mosquito repellents, oil of citronella being the most promising There are now numerous mosquito "chasers" on the market. Most of them are effective, although rather expensive, and perhaps in most cases not so efficient as those recommended by entomologists and medical men. They are usually composed of one or more essential oils which are combined with some heavy oil or grease and are to be applied as lotions, sprays, or ointments, depending on their consistency (15, 17, 48).

How do these substances afford protection against mosquito bites? One writer claims that mosquitoes are guided in the dark to a person by the odors emitted from the skin, and that all that is necessary is to disguise the smell of the skin. Therefore, he infers that mosquito repellents are not really repugnant to these insects, but are effective merely because they change or disguise the attractive odors from the human skin. A second writer believes that these substances repel directly by emitting odors or vapors which are disagreeable or harmful to the mosquitoes (38).

Before 1889 there were a few fly repellents on the market. During the first decade of the twentieth century the proprietary preparations of this character had greatly increased, and during this period were introduced the two most important sprays to protect dairy cows (4, 7, 14) and the mixtures designed to prevent fly eggs from being deposited in wounds of live stock. With the latter object in view much experimental work has been done (1, 21), and one of the control measures developed, and a very effective one, is the use of a repellent mixture of one part furfural and four parts of pine-tar oil.

Repellents are included among the control measures for blowflies (6, 22), tsetse flies, botflies, certain simuliid or black flies (3), certain midges causing sandfly fever (15, 49), and a few beetles (42), moths, and other insects (11, 12, 41); but in most cases repellents, for various reasons, are not reliable remedies.

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NOTES ON THE CHEMOTROPIC RESPONSES OF CERTAIN INSECTS

By A. C. Morgan and S. E. Crumb, *Associate Entomologists, Bureau of Entomology, U. S. Department of Agriculture*

Abstract

This paper discusses very briefly some of the studies on insect chemotropism conducted over a period of 14 years at Clarksville, Tenn. During the period of investigation many different chemicals and substances were tested. The observations and experiments covered insects belonging to several orders including Lepidoptera, Coleoptera, Hymenoptera, Diptera, and Thysanoptera. Though in most instances the results were only indicative, the experiments brought out the fact that hornworm moths were strongly attracted to amyl salicylate and large numbers of moths were caught in the field by placing this chemical in suitable traps. Three types of apparatus are described.

INTRODUCTION

The subject of chemotropic responses of insects has occupied the attention of the workers at the Tobacco Insect Laboratory of the Bureau of Entomology, located at Clarksville, Tenn., since 1912, when the first experiments indicated the decided responses of thrips to certain aldehydes. Some of the observations have been published, as noted in succeeding pages, and a more extended paper upon the chemo-tropic responses of tobacco-hornworm moths is in preparation.

The observations herein listed, although incomplete, are indicative, in many instances, of a very decided attraction of insects to certain chemicals. These preliminary records are offered with the hope that they may be of service to other workers interested in this promising factor in insect control.

RESULTS OBTAINED WITH LEPIDOPTERA

LARVAE OF THE TOBACCO HORNWORM, *Protoparce sexta* JOH.

Sixty-nine species of plants, after having been dipped in a steam distillate of either tobacco or jimsonweed leaves, were offered to larvae of *Protoparce sexta*. Mullein (*Verbascum thapsus*) and morning-glory (*Ipomaea hederacea*) were fed upon more freely than the others, but these were nibbled to a slight extent even when untreated. The larvae also fed slightly upon treated leaves of pokeweed (*Phytolacca decandra*), smartweed (*Polygonum* sp.), horehound (*Marrubium vulgare*), elder (*Sambucus* sp), rape, *Malva rotundifolia*, thistle (*Cirsium* sp.), *Paulonia imperialis*, apple, *Plantago lanceolata*, *Rumex crispus*, sycamore, white mulberry, *Bidens* sp., and red clover. Untreated plants of the foregoing species were not fed upon.

When sheets of paraffin were impregnated with an ether extract of green tobacco leaf, the larvae fed upon them very freely for several days until the excrement consisted entirely of pellets of paraffin. They seemed to obtain no nourishment from this material and grew thin and shrivelled but continued to feed.

MOTHS OF TOBACCO HORNWORMS

OVIPOSITION RESPONSES: A series of experiments was conducted in specially constructed cages, 12 feet square and 6 feet high, to find, if possible, an oviposition stimulant for hornworm moths. Tobacco leaves were suspended in the cages, half of which were sprayed with a solution of a chemical and the other half served as controls. Most of the materials tested were aminoacids. Glycocoll alone showed positive results in concentrating oviposition but not enough to encourage further experiments.

FEEDING RESPONSES: The experiments to discover a feeding attrahent were more encouraging. Near the close of a year of tests, amyl salicylate was found to be decidedly attractive to the moths. In cage tests made late in August, 1925, it was found that more visits were made by the moths to a black rag scented with amyl salicylate than were made to a bouquet of fresh blossoms of jimsonweed, which is the insect's preferred natural source of food.

A trap cage similar in construction to an enlarged house-fly trap was devised in 1926 and six of these cages were placed in and around a 16-acre field of tobacco. The traps were visited daily for the removal of the moths and rebaiting. During the period of exposure, July 20 to September 22, 665 males and 412 females of *P. sexta* and 566 males and 543 females of *P. quinquemaculata* Haw. were trapped. The infestation of the trapped field during this period averaged 2.87 worms and eggs per plant, while the surrounding untrapped fields averaged slightly more than 6 worms and eggs per plant.

MOTHS OF OTHER SPHINGIDAE

Thirteen species of sphinx moths were caught in the traps baited with amyl salicylate during 1926. Only a few moths of species other than Sphingidae were caught.

CUTWORM MOTHS

Of the numerous materials tested nothing was found which equalled fermenting fruits as an attrahent for cutworm moths. Ethyl alcohol, nitrobenzene, artificial musk, and civet were also slightly attractive to the moths.

CUTWORMS

In the experiments with cutworms an apparatus made of galvanized iron was used. It consisted of a round central chamber 6 inches in diameter and 3 inches high connected by narrow passages with each of six radiating chambers 8 by 4 by 3 inches in size. These radiating chambers were exactly alike and equally accessible. They were fitted with tight covers provided with ventilators which could be closed or opened to any desired degree. The central chamber was provided with a cover bearing a tall ventilator tube by means of which a gentle current of air could be drawn through the outer chambers into the central one. The larvae were introduced into the central chamber at the beginning of an experiment. A shallow pasteboard tray containing 36 grams of moistened bran carrying the substance to be tested was placed in alternate compartments, and in each of the other radiating chambers only the moistened bran. The apparatus was frequently scrubbed and aired, and this was always done prior to the testing of a new material. The duration of each experiment was 24 hours. Larvae were seldom exposed more than once, since they showed a strong tendency to become indifferent to odors when utilized a second time.

Of the substances tested, lemon juice, lemon peel, oil of orange peel (sweet), citral, amyl nitrate, oil of sweet birch, and salt were not attractive; amyl butyrate and citric acid were slightly attractive; corn syrup was attractive only after it had fermented; and ethyl acetate, ethyl aceto-acetate, nitrobenzene, and vinegar were distinctly attractive.

OTHER LEPIDOPTERA

In the course of the experiments with mosquitoes it was noted that peach-tree borers, *Aegeria exitiosa* Say, from near-by trees and a species of geometrid moth were attracted to stale urine.

An unflavored poisoned-bran bait has been found to be a satisfactory means of controlling the larva of the tineid, *Acrolophus popeanellus* Clem. A publication embodying the results of these tests is in preparation.

Under certain conditions, the active factor of which is not fully understood, a poisoned-bran bait flavored with nitrobenzene has given good results against larvae of one of the sod webworms, *Crambus caliginosellus* Clem., in tobacco fields. Seven experiments during 1922 gave an average control of 83 per cent. A bait flavored with syrup gave practically no control.

RESULTS OBTAINED WITH BEETLES

THE TOBACCO BEETLE, *Lasioderma serricorne* FAB.

The apparatus used in the cutworm experiments was also used in studying the reactions of the tobacco beetle and gave fairly consistent results. The odorous material to be tested was placed in open tin boxes in the outer chambers, 3 baited chambers alternating with 3 checks where but one substance was being tested. Where two materials were being tested they were separated on each side by two check chambers, while two baited chambers, without checks, were used for each material where three attrahents were tested in competition. Crumpled paper in which the beetles might find places of concealment was also placed in the outer chambers. Boiled linseed oil, tobacco, yeast cake, starch, and a mixture of starch and peptone were found to be attractive. The mixture of starch and peptone was more attractive than starch alone. A single experiment with nicotine indicated that this compound might be attractive. Coumarin and agar-agar appeared to be very slightly attractive.

TOBACCO FLEA BEETLE, *Epitrix parvula* FAB.

A series of experiments were conducted in an effort to find a satisfactory repellent for the tobacco flea beetle, *Epitrix parvula*. The apparatus used in these experiments consisted of four pieces of glass tubing one-half inch in diameter set horizontally in a block of wood in the form of a cross. Holes were bored through the block to provide connection between the tubes. One arm of this figure was attached to a filter pump, as a source of suction, and was screened so that the beetles could not enter it. The opposite arm, which was darkened, served as an inlet for the beetles. Air alone was drawn through one of the remaining pair of equally illuminated tubes, while the odor to be tested was drawn through the other.

One hundred beetles were used in each experiment and after 45 minutes' exposure the beetles in each arm were counted. The experiment was then repeated after reversing the positions of the baited and check tubes.

Tests were made with creolin, nitrobenzene, pyroligneous acid, cresol (para), cresol (ortho), cresylic acid (para), cresylic acid (ortho), oil of pennyroyal, pyridine, benzoyl chloride, allyl isothiocyanate, naphthalene, and alkesol. All of these were repellent, but pyridine, benzoyl chloride, cresylic acid (para), and alkesol were most repellent.

The beetles were definitely attracted to wads of cotton moistened with a steam distillate of green tobacco in preference to cotton moistened with water, but did not show any preference for cotton moistened with a steam extract of jimsonweed leaves.

RESULTS OBTAINED WITH DIPTERA

MOSQUITOES

The following substances were exposed in tin boxes surrounded by sheets of sticky fly paper, in a greenhouse containing many adults of *Culex pipiens* L.: Petrolatum (liquid yellow), lemon juice, peach, petrolatum (liquid white), water, corn syrup, oil of rhodium, oil of tar, banana, oil of cloves, peach-leaf extract, licorice, oil of cedar, beef extract, anisic aldehyde, cinnamic aldehyde, butyric acid, oil of rose geranium, plum, apricot, and apple. Cnly the fruits attracted mosquitoes to a noticeable extent and these drew more males than females.

MOSQUITO OVIPOSITION

In experiments with *Culex pipiens*, some results of which have already been published,[1] it was found that ovipositing mosquitoes were attracted to old yeast infusion and stale urine, after these had acquired a sewage-like odor, and also to hydrogen sulfide and methane. It has since been learned that an infusion of potato starch rather strongly attracts ovipositing mosquitoes, although it has very little odor. Caprylic acid, caproic acid, iso-butyl alcohol, and an infusion of casein apparently induce mosquitoes to oviposit upon water containing them in preference to plain water.

HOUSE-FLY OVIPOSITION

In experiments with house-flies, the results of which have already been published,[2] it was found that under the conditions of the authors' experiments house-flies preferred as a nidus a medium which was exhaling certain odors such as those of carbon dioxide, acetic acid, sodium hydroxide, formic acid, propionic acid, sodium sulfate, or butyric acid.

HOUSE-FLY LARVAE

An apparatus was used in the experiments with house-fly larvae which consisted of a T-shaped glass tube of 18 mm. bore with trap compartments at the ends of the arms and so arranged that an odor could be drawn into the stem of the T through one or both arms by means of a filter pump. The larvae were introduced into the stem of the apparatus and the whole was kept in complete darkness. Tests were made with ammonia, valeric acid, iso-trihydrate, urea, hippuric acid, succinic acid, aspartic acid, acetone, butyric acid, acetic acid, benzoic acid, acetaldehyde, iso-butyl alcohol, propionic acid, hydrogen, hyrdogen sulphide, carbon dioxide, glycerine, oxygen, ethyl alcohol, and phenyl acetic acid' all of which are present in fermenting manure. Of these, ammonia' acetaldehyde, iso-butyl alcohol, hydrogen, and phenyl acetic acid were found to attract the larvae.

A small number of experiments indicated that house-fly larvae became indifferent to the odor of manure when ready to form puparia, and there was no special attraction in the odor of fresh earth at this time. Larvae of all other ages which had been bred in wet bran were found to be strongly attracted to fresh manure.

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[1] Odor Attractive to Ovipositing Mosquitoes. Ent. News, Vol. 35, pp. 242-243, July, 1924.

[2] The effect of Certain Chemicals Upon Oviposition in the House Fly (*Musca domestica* Linn.). Journ. Econ. Ent., Vol. 10, pp. 535-536, 1917.

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MISCELLANEOUS FIELD TESTS

In arranging certain field experiments, white granite-ware pans of about 2-quart capacity were set in a row on stakes 2 feet high, and each one was half filled with water to which was added 1 cc. of the chemical to be tested. A considerable number of chemicals, each of which was tested in two pans, were exposed at the same time, with three pans containing only water and placed at intervals in the series to serve as checks. The insects caught were removed from the solutions daily and the liquid or chemical in the pans was renewed every second day. A field record was made, and then the insects collected at each bait were prepared for future study. The contents of the pan were strained through a piece of cheesecloth which was then tied, labelled, and placed in a jar of alcohol.

The areas in which experiments were conducted included a field white with the blossoms of the field daisy (*Erigeron annuus*), oat fields, margins of woods, hedge rows, a cane brake, a slaughter-house lot, and a livery-stable yard.

The materials tested included five alcohols, seven aldehydes, four ketones, twenty-three acids, eighteen esters, ten salts, ten essential oils, sixteen petroleum derivatives, and twenty-nine miscellaneous chemicals. The more interesting examples of insect attraction are shown below.

THRIPS

In an oat field infested with *Limothrips cerealium* Haliday and *Frankliniella tritici* Fitch, these insects were attracted to the following chemicals, which are listed in the order of diminishing attractiveness: Cinnamic aldehyde, salicylaldehyde, anisic aldehyde, benzyl alcohol, cinnamyl alcohol, benzaldehyde, nitronbezoic acid (ortho) nitrobenzene, nitrobenzaldehyde (ortho), nitrobenzoic acid (meta), oil of bitter almonds (true). A number of salicylates and benzoates were also somewhat attractive. Practically no thrips were collected from the check pans containing water.

Limothrips cerealium and *Frankliniella tritici* occurred in the field in the proportion of 40 of the former to 1 of the latter species, but in the pans scented with cinnamic aldehyde 4.6 times as many of the latter species were taken as of the former. Less notable specific attraction was noted for some of the other compounds.

BEES

Bees, mostly of solitary species, were taken in moderate numbers in pans scented with cinnamic acid, formic acid, benzaldehyde, eugenol, anisic aldehyde, citral, benzoyl chloride, cinnamic aldehyde, and cinnamyl alcohol. Petroleum derivatives, including crude petroleum, paraffin oil (liquid yellow), oil of vaseline, kerosene (water white), petrolatum (liquid white), pentane, and cylinder oil attracted a few bees. The check pans caught almost no bees.

BEETLES

One of the cantharids, *Chauliognathus marginatus* Fab., gave a positive reaction to the following chemicals, which are listed in the order of diminishing attractiveness: Anisic aldehyde, cinnamic alcohol, cinnamic aldehyde, geraniol, anethol, and eugenol. The check pans took but one specimen of this species.

A small weevil, *Odontocorynus scutellum-album* Say, was observed in a few instances to be attracted to the pungent fumes of pyridine. (The boll weevil was not attracted to this compound.)

A flower-frequenting beetle, *Euphoria melancholica* Horn, was attracted to anisic aldehyde, cinnimac aldehyde, and oil of anise.

The spotted cucumber beetle, *Γiabrotica duodecimpunctata* Fab., was attracted to cinnamic aldehyde and cinnamic alcohol.

FLIES

Large numbers of a small fly (*Swammerdamella* sp.) were attracted to pans scented with cinnamic alcohol. In these pans the sexes were caught in the proportion of 40 males to 1 female. Anethol, anisic aldehyde, cinnamic aldehyde, oil of anise, oil of fennel. and sweet oil of orange were also attractive.

A mycetophilid fly of the genus *Sciara* was taken in large numbers in pans of water exposed in an oat field and scented with anisic aldehyde. Cinnamic alcohol also attracted them to some extent. Most of those trapped were teneral adults indicating that they had bred on plants near at hand.

Large flies, principally belonging to the *Sarcophagidae*, were attracted in considerable numbers to the pans containing cylinder oil, petrolatum, geraniol, crude petroleum, paraffin oil (yellow), a mixture of amygdalin and sweet oil of almond, citronellol, citronellal, butyl alcohol, and formic acid. None of these flies, however, were taken in the check pans.

INFLUENCE OF SPRAY PRACTICES ON ARSENICAL RESIDUES

By HARRY C. MCLEAN and ALBERT L. WEBER,

N. J. Agricultural Experiment Station

ABSTRACT

Heavy spraying of winter apples in June in New Jersey during a season with more than normal rainfall means that later sprays cannot be applied without exceeding the new tolerance. Dusted fruit showed but traces of arsenical residues. Spraying up to July 1st followed by dusting showed very low residues at harvest time. The heaviest residues occur on the lower parts of the trees.

The announcement by the Food, Drug and Insecticide Administration of the United States Department of Agriculture that the spray residue tolerance for the 1928 crop of fruit is to be decreased 60% from that for the 1927 crop, presents a problem that deserves the serious consideration of the entomologist, horticulturist and fruit grower.

Investigations were instigated at the New Jersey Experiment Station during the past season to determine what spray practices should be adopted in order to keep spray residues on our apples at a minimum.

In order to determine the influence of different amounts of lead arsenate, date of application, method of application and the use of other accessory materials upon the arsenical residues at harvest, as well as to study the distribution of residues on the trees, a series of experiments were conducted on specially sprayed trees in our orchard on the Agricultural Experiment Station Farm at New Brunswick. Investigations were also pursued in 29 orchards distributed in seven counties of the State. Only fall and winter varieties were included in our studies. On an average four varieties were included in the test at each orchard. Altogether 20 varieties of apples were studied. The spray formulas and schedules as recommended by the New Jersey Agricultural Experiment Station were followed.[1] The amount of lead arsenate used per gallon of spray mixture varied from .02 pounds to .04 pounds.

WEATHER CONDITIONS

The average rainfall over the territory in which these studies were made is shown in Table 1. The total rainfall from May 15 when petal fall sprays were on an average applied to October 31, was 26.92 inches which was 4.99 inches above normal for this period. While the months of May and June were dry, the remainder of the period, with the exception of September, was very wet. An application of lead arsenate on apples July 1 received about 5¾ inches more rainfall than one made on August 1st.

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[1] Circular 201, N. J. Agr'l Exp. Sta. 1927.

METHODS OF ANALYSIS

The samples of fruit in each instance were secured from 25 representative trees of each variety. The analysis for arsenic was made by the Modified Gutzeit method. The methods described by Robinson and Hartman[2] for obtaining a solution of the residues on the fruit were used. Where the fruit was very waxy and as a means of comparison of results the combination sulfuric acid and nitric acid digestion method was resorted to. Separate analysis of the amounts of residue found on skin, calyx and stem of the fruit were made in all cases. No appreciable amount of arsenical residue was found in the more or less closed calyx (internal calyx) of any of the varieties and the results therefore are not included.

TABLE 1. THE AVERAGE RAINFALL IN THE AREA IN WHICH THE STUDIES WERE MADE

Date	Rainfall, Inches	Normal +Above, —Below	Rainy Days No.
May 15 to 30	1.17	[1]	5
June	2.66	—1.10	8.87
July	5.74	+ .97	8.60
August	7.93	+2.89	11.40
September	2.55	—1.07	5.00
October	6.87	+3.30	10.00
Total	26.92	+4.99[2]	

[1]Entire month below normal.

[2]June 1 to October 30

INFLUENCE OF AMOUNT OF LEAD ARSENATE APPLIED AND TIME OF APPLICATION ON RESIDUES

An analysis of the field records and the chemical data representing about 4000 chemical determinations gave the average results which are shown diagramatically in Figure 65. The data indicate the maximum residues found in each case as a result of treatments. Sprays applied earlier than June have little effect on residues left at harvest, therefore only June and July-August were considered. The height of the graphs represents the arsenical residues on the apples when mature, where a definite quantity of lead arsenate was applied as indicated per tree during the given periods.

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[2]Oregon Agr'l College Exp. Sta. Bul. 226.

. The total number of pounds of lead arsenate applied per 25'x25' tree in June and in July-August are compared with the maximum arsenical residues found on 2¾" to 3½" apples when harvested in September and October.

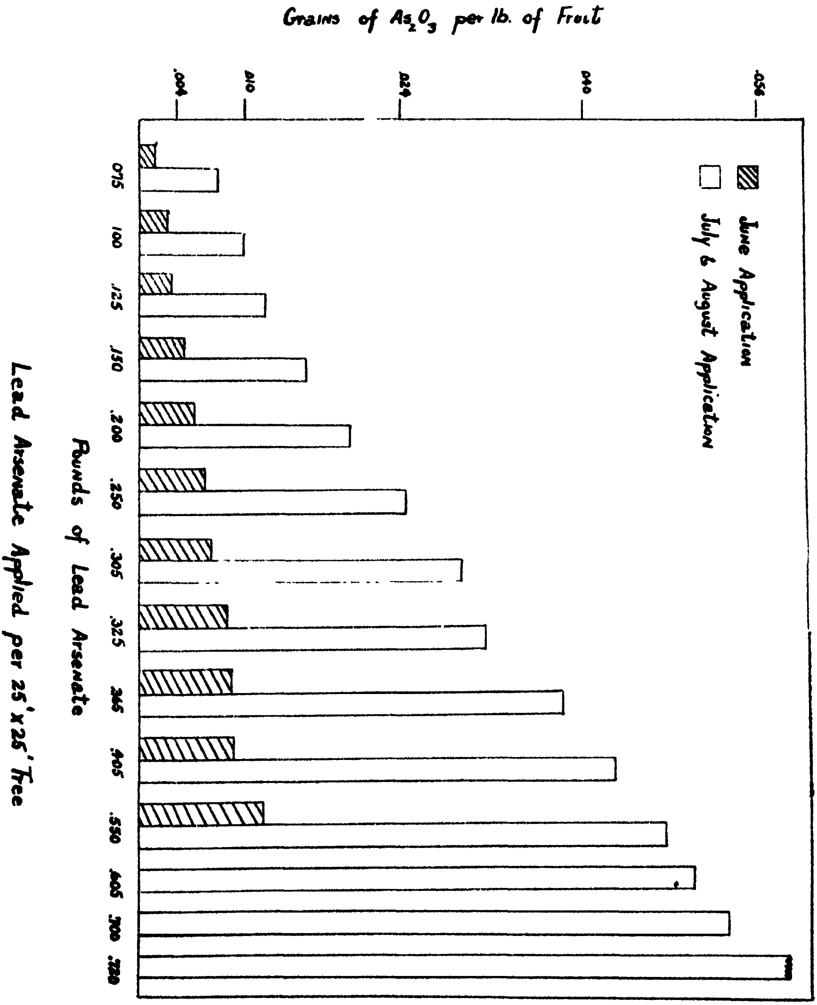

FIG. 65.

The June sprays were applied in from 1 to 3 applications, varying in date of application from June 1st to June 28th. The July-August applications were from 1 to 2 in number and the dates of application varied from July 20 to August 10.

June Sprays Leave Light Residues

The striking fact brought out by a study of the data as represented in the diagram is that under reasonably heavy rainfall conditions such as existed during the past year, heavy applications of lead arsenate can be made up to July 1st without seriously exceeding the new maximum spray residue tolerance (.01 gr. of As_2O_3 per lb. of fruit) on fruit maturing in September and October. It is also apparent that where heavy applications of lead arsenate have been made in June no additional amounts can be safely applied at a later date. The largest application of lead arsenate per tree during the month of June where no following sprays were added as shown by the data represents .55 pounds and was applied in two applications, on June 3rd .24 lbs. and on June 15th .31 lbs. The apples at harvest time contained residues of .012 gr. As_2O_3 per pound. In this instance, considering the sprays made earlier than the first of the month of June, a total of 1.28 lbs. of lead arsenate per tree was applied in five applications.

July and August Sprays Leave Excessive Residues

In another case a total of 1.07 lb. of lead arsenate per tree was applied in seven applications, the last of which was made on August 10. The fruit was found to contain .031 gr. As_2O_3 per lb., showing that although the amount of lead arsenate applied was less than in the former case, considerably larger residues remained, because of the late sprays, although fairly light applications were made throughout the season.

Although data were not secured on the subject it appears that aside from the removal by washing June sprays do not leave excessive residues since the spray at that time is placed on a relatively small apple. As the apple grows larger the ratio between the weights of the arsenic trioxide, and of the apple becomes greater, so that the amount of As_2O_3 per lb. of fruit becomes very small. The later the applications are made, however, the larger the surface of the fruit to be covered and less time for removal by weathering, hence, the larger residues at maturity of fruit.

If heavy applications of .20 lb. to .55 lb. of lead arsenate per 25'x25' tree are made up to July 1st a certain amount of residues will be accumulated on the foliage and fruit. Subsequent washing will cause the residues to gradually accumulate upon the lower branches of the tree, as shown later in Tables 2 and 3, with the result that the mature apples in this zone may show residues slightly over .01 gr. of As_2O_3 per lb. On the other hand, if the months of August, September and October had been very dry, we might have found the residues to have been more evenly distributed, resulting in residues much under .01 gr. As_2O_3 per lb.

due to there being no concentration in the lower zone. Where heavy sprays have been applied up to July 1 no additional arsenical sprays can be applied without exceeding the maximum tolerance. However, if a small amount of lead arsenate not exceeding .1 pound per tree is applied in June, a further amount of .1 lb can be added in July without serious consequences. In sections of the country where rainfall conditions are similar to ours, and there are two or more broods of codling moth which cannot be controlled by early spraying, according to the above data, there remains only a choice of continued spraying and later washing the fruit, or of adopting some other method of control.

Heavy Residues on Small Apples

Where spraying has been fairly uniform, the small apples 2¼" to 2½", such as Winesaps, were found to contain about 25% more residues than the 2¾" to 3½" apples. This was less noticeable on apples sprayed before July 1st than those which were sprayed from July 20 to August 10th. It may be explained by the fact that the residues on an average are distributed over the apple as follows: On peel 45%; in stem cavity 33%; in calyx end 22%. Since the maximum residue tolerance is placed on the pound basis, we would have more stem ends in a pound of the small apples, and we would also have a larger surface area to receive the spray material, hence late sprays would leave larger residues on a pound of the small apples than large ones.

In order to decrease residue content per pound of fruit the grower should adopt orchard practices such as proper pruning and thinning which will enable him to grow large apples.

Heavy Residue Fruit on Lower Limbs

All the heaviest residue fruit is found on the lower limbs of the trees. This is, no doubt, largely due to the residues being concentrated there due to dripping of the spray at time of application, and also to residues gradually washing from the higher branches.

Regardless of the quantity of lead arsenate applied in June sprays, where no July or August sprays were added, only 25 to 35% of the fruit on each tree contained .01 gr. of As_2O_3 per lb. and this was all in the lower branches of the tree.

Table 2. The Distribution of Spray Residues on Delicious Apples from Various Sections of the Trees at Picking Time

Zone (Height from Ground)	Date of Last Spray	Grains of As_2O_3 per lb. of Apples			
		Peel	Stem	Calyx	Total
10′ & over	June 16th	.0018	.0007	.0015	.0040
6′–10′	June 16th	.0032	.0008	.0012	.0052
0′–6′	June 16th	.0041	.0032	.0032	.0105

TABLE 3. THE DISTRIBUTION OF SPRAY RESIDUES AND INSECT INJURY ON HEAVILY SPRAYED STAYMAN TREES AT MATURITY

Apparent Residues	Grains As_2O_3 per lb. of Apples Total	Percent of Total Apples in Zone	Percent Insect Injured Fruit
	10′ & Over Zone		
Light	.0180	36.84	36.25
Medium	.0198	49.71	
Heavy	.0231	13.45	
	6′–10′ Zone		
Light	.0288	28.10	25.98
Medium	.0373	19.10	
Heavy	.0420	52.80	
	0′–6′ Zone		
Light	.0386	13.67	17.29
Medium	.0487	36.90	
Heavy	.0501	49.42	

Tables 2 and 3 show how the residues are distributed in various parts of the tree. Table 2 gives the analysis of fruit from trees which were not sprayed in July and August and which received lead arsenate in June at the rate of .3 lb. per 25′x25′ tree. Analysis representing the maximum amount of residues found in each zone on the tree, as well as the distribution of the residues on the apples, are shown in the Table. It should be noted that the higher the fruit on the tree, the lower the amount of spray residues. The largest residues are found in the stem and calyx ends on the lower branches of the tree. While an average sample of the entire crop on trees in a particular orchard showed residues under .01 grains As_2O_3 per lb. some of the apples on the lower zone of tree on analysis proved to be considerably over .01 gr. of As_2O_3 per lb.

Table 3 shows the analysis of fruit from various zones on trees which have been very heavily sprayed. These trees received a total of 2.48 lbs. of lead arsenate per tree during the entire season, .56 lb. of which was applied in July and August.

In this case all the apples were picked from the trees and the apples from each tree separated into groups of light, medium and heavy residue according to the amount visible.

The total amount of insect injured apples was determined in each zone at the time the samples were taken.

On these particular trees the per cent of the total crop in the 0′–6′, 6′–10′ and 10′ and over zones was 34.2%, 47.5% and 18.3% respectively. These apples were sprayed very thoroughly and uniformly throughout the season, the last application of spray being on August

10th, yet the residues for the three zones varied from .0231 grains to .0501 grains of As_2O_3 per lb. of apples, from the 10′ and over zone to the 0′–6′ zone. The corresponding percentages of clean fruit for the two zones are 63.74% and 82.70% respectively. No apples could be found which were under .01 gr. of As_2O_3 per lb.

RESIDUES LEFT ON DUSTED APPLES

In only two cases data were secured on dusted apples. In one instance beginning with the petal fall application, the total dust applied 25′x25′ tree was equivalent to .105 lb. of lead arsenate, the last applications being made June 10th. The apples contained from a trace to .0007 gr. of As_2O_3 per pound when harvested.

In the other case, the fruit received the regular liquid spray containing lead arsenate on June 6th, and were subsequently heavily dusted with a 10% lead arsenate dust, the last dust being applied August 5th, with the result that the apples, when picked, showed an As_2O_3 content of .0029 gr. per lb. The data were not sufficient from this one years investigations to enable us to draw any very definite conclusions concerning the influence of pressure at which the spray should be applied, the effect of different stickers and accessory materials, or method of application on the amount of residues left on the fruit at harvest. However, during 1928 we expect to be able to add to the information already at hand not only on apples, but on other fruit as well, so that definite conclusions will be warranted.

It is evident from the above results that if late July and August sprays containing lead arsenate are necessary we must in order to maintain the 1928 spray residue tolerance do one of the following:

1. Find a more or less cheap substitute for lead arsenate which will control injurious insects and which will leave no extensive objectionable residues on the fruit at maturity.
2. Use arsenical dusts which will leave no extensive residues.
3. Remove chemically the present used arsenical sprays from the fruit when harvested.

Experiments carried out in New Jersey and reported elsewhere[3] have demonstrated that the mechanical cleaners will not remove spray residues sufficiently under our conditions. Chemical methods show promise of giving us excellent results. Storage tests on chemically treated fruit are still in progress however.

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[3] Some results of a study of spray residues on apples in 1927. Presented in December, 1927. State Hort. Soc. Rept. 1927. (In press.)

RESIDUES NOT ALWAYS VISIBLE

It might be mentioned at this time, that it is not always possible to judge the amount of residues present by visibility standards, unless one knows what spray formula has been used.

When the last spray application made consists of only the 10% lead arsenate paste and a small amount of casein-lime along with the water, little apparent residues will be left although very high arsenical residues may be present. The lead arsenate in this case appears to form a thin film around the apple and only a slight oiliness is visible.

SUMMARY

Experiments conducted in New Jersey during a season in which rainfall was 4.99 inches above normal or a total of 26.92″ of rainfall show that heavy applications of lead arsenate may be applied to fall and winter varieties of apples up to July 1 without seriously exceeding the spray residue tolerance for 1928.

When sprayed heavily in June no further applications can be made without surpassing the new tolerance.

Dusted fruit showed but a trace of arsenical residues when picked. Apples sprayed up to July 1st and then followed by dusting showed very low residues at harvest.

The heaviest residue fruit in all cases was found on the lower section of the tree.

The authors wish to express their appreciation of the helpful advice and cooperation given them by Dr. T. J. Headlee, Prof. M. A. Blake and Prof. A. J. Farley, of the Experiment Station staff, also to Mr. Walter McClatchey, who assisted with a greater part of the field work.

USE OF ARSENITES IN THE CONTROL OF MORMON CRICKETS

By F. T. COWAN, *Bureau of Entomology*

ABSTRACT

Poisoned bran mash did not prove entirely satisfactory. Sodium arsenite, liquid or dry, and calcium arsenite proved very efficient, especially when the pests were concentrated in small areas and before there was much movement from the hatching grounds.

In 1921 and 1922 the Mormon cricket made its appearance in the northern end of Camas Valley in western Montana. Undoubtedly it had been present in the mountains surrounding this and other valleys for a good many years, since it is native to this part of the state, but this was the first time since about 1896 that crickets had been noticed in damaging numbers. No extensive damage was done in 1921 and the three years following. The first serious damage was recorded in 1925. In 1926 the outbreak reached its height and the damage for that year was estimated as high as $125,000. In Camas Prairie Valley alone, a community which in ordinary years produces from 75,000 to 100,000 bushels of wheat, only about 15,000 bushels were produced in 1926. Practically all of this grain was threshed from fields in the southwestern corner of the valley, which escaped the ravages of the crickets. In the remainder of the valley the wheat was a total loss. In other wheat-growing sections of Sanders County the damage was practically 100 per cent. In Lake County the damage to the wheat crop was equally as high, and some damage to alfalfa was also recorded. The infestation spread from a small beginning in 1921 to an area of some 256,000 acres at the end of 1926. It embraced the western part of Sanders County and a large portion of the eastern half of Lake County, Montana.

Heretofore the accepted method for controlling the Mormon cricket had been the use of poisoned bran mash. This had been used with more or less success in other parts of the Rocky Mountain region, and since it was the best method known at that time, the farmers in both Lake and Sanders Counties organized, under their county agents, for a control campaign on that basis. However, apparently very mediocre results were obtained, and the campaign was given up. This apparent lack of success may have been due to several causes, but perhaps the most important reason for abandoning the campaign was that the farmers could not see results. They mixed and scattered the bait faithfully, but when they looked for dead crickets on the treated areas, a few days later, they were disappointed in finding apparently as many live crickets as before, and, in most cases, no dead ones. The Mormon cricket, after reaching a certain stage in its development, is almost constantly moving, and the crickets that had eaten the poison had moved on before dying, while others had moved in to take their places.

Since poisoned bran mash apparently did not give the desired results, it was necessary to find some method by which a quick effective kill could be brought about. Experiments were carried out during the summer of 1926 with liquid sodium arsenite diluted in various proportions to form sprays. This method had proved highly successful in South Africa and other countries, against grasshoppers having habits, similar to those of the Mormon cricket, of migrating and gathering in compact groups for shelter and warmth. This liquid was sprayed on the crickets and produced exceedingly good results. However, any spray strong enough to kill crickets was found to burn the vegetation seriously. These mixtures therefore could not be safely used in crops. Later in the summer a sodium arsenite powder was obtained and used undiluted as a dust. Very good kills were obtained with this dust, but damage to vegetation was as great or even greater than with the sprays. However, it was felt that since great numbers of cricket eggs were laid in more or less barren soil, the spray or dust could be used to advantage on the hatching grounds.

During the early part of the summer of 1926, with the assistance of Mr. W. B. Mabee, state extension entomologist, steps were taken toward the organization of a cricket control campaign for 1927. Meetings were held during the winter and early spring in all of the infested districts and the farmers were organized. It was decided to have one man, experienced in insect control work, in each county to take active charge of the campaign. Each county raised about $4,000, and this money, coupled with $2,250 from the United States Indian Service, was used to buy materials and dusting equipment and to pay the salaries of the men in charge of the work. The work of applying the dust and poisoned bran was done by the farmers.

During the winter of 1926–27, experiments were carried out in the United States Bureau of Entomology laboratory at Billings, Montana, with sodium arsenite powder diluted with hydrated lime. In this work it was found that grasshopper nymphs could be killed with a mixture of one part of sodium arsenite powder to four parts of lime, and that little or no burning of the foliage resulted.

Following these experiments, early in the spring of 1927, field tests were made in various crops with the one-to-four dust. It was found in these tests that the dust applied at the rate of five pounds to the acre was sufficiently strong to obtain estimated kills of from 75 to 90 per cent in practically every instance. No burning whatsoever was observed during these tests in either grain or alfalfa. Some burning, however, was recorded later in alfalfa, when the dusting was followed by rain or when the vegetation was wet with dew at the time of application. Such damage was slight, however, and was of little consequence. No burning was recorded in wheat.

An item that did not come to mind at the time the experiments were being carried out with sodium arsenite powder was the scarcity of the material. About the time that the supply of sodium arsenite powder in the United States had been exhausted, it was learned thru the efforts of Mr. Mabee that calcium arsenite was also used as a weed killer, and since it was much more plentiful and cheaper than the sodium arsenite, it was given a trial. The results were very good, but the experimental work showed that it was necessary to use a one-to-three mixture with lime, and to apply it at the rate of eight pounds per acre, instead of five of the sodium arsenite mixture. However the cost was still much less and the results were practically the same.

The success of any campaign depends upon the work being done at the time when the most good can be accomplished. With Mormon crickets this work should be done early in the spring, just after the hatching is completed and before the young crickets have had a chance to move very far from the hatching grounds. At this time they cover a much smaller area than after they start to spread out and migrate, and can therefore be treated with much less material and labor. The real concentrated migrations do not, as a rule, take place until the young have reached about the fourth instar or about one month after hatching. The best time of day for dusting thus far has been found to be early in the morning or late in the evening. At these times the crickets gather in small compact groups, sometimes two or three inches deep and a foot or more across, and since the success of the dust depends upon its coming in contact with the insects, such groups can be treated with a minimum expenditure of material and labor.

The dust should be distributed at the rate of five pounds to the acre of the sodium arsenite-hydrated lime mixture, or eight pounds to the acre of the calcium arsenite mixture. It is not always necessary to cover an entire area, since the material must be dusted on the insects wherever they are found. In case the dusting is done when the insects are evenly distributed, the dusters should be run with the nozzles within a few inches of the ground, over strips from eight to ten feet wide. Any good rotary dusting machine serves well in applying the dust, but the machine most suited to conditions in cricket country is one that can be mounted on a saddle horse or on the rear end of a light truck or wagon. This type of duster can be used over all kinds of land, whether rough or smooth, and is very efficient.

In the work in western Montana for the season of 1927, approximately 9,000 pounds of calcium arsenite, 2,000 pounds of sodium arsenite, and enough hydrated lime to make the proper mixtures were used. In all, about $9,000 was spent in the two counties, part of which was spent in salaries for supervisors and for the necessary equipment to carry on the work. For this amount of money and the labor which was expended, practically *100 per cent control* was effected, saving for the farmers a crop with an estimated value between $125,000 and $150,000. Although the total acreage for the two counties was a little less in 1927 than in 1926, the increased yield, due to a better growing season, more than offset the decrease in acreage, and the total yield was believed to be as great or even greater than it would have been in 1926, when the Mormon cricket caused a crop failure. The crop of 1927, in the opinion of the farmers and those otherwise connected with the work, would probably have been a total loss had not the campaign been put on.

I assume full responsibility for the accuracy of the statements and references given in this manuscript. I believe the conclusions offered are fully warranted, and certify that all tables and computations have been carefully verified by me.

A METHOD OF VOLATILIZING CARBON BISULFIDE FOR SOIL FUMIGATION

By H. K. Riley, *Department of Entomology, Purdue University Agricultural Experiment Station*

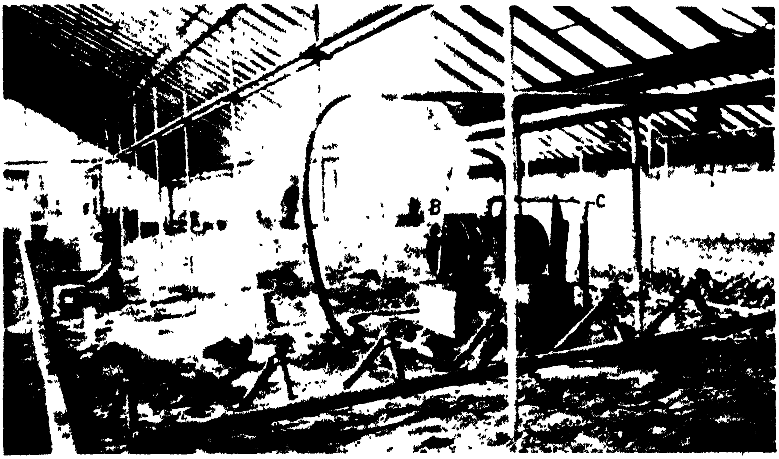
Abstract

A method of volatilizing carbon bisulfide with steam was successfully employed in soil fumigation tests for the control of the greenhouse centipede (*Scutigerella immaculata* Newp.) infesting ground beds in a commercial greenhouse at Indianapolis, Indiana.

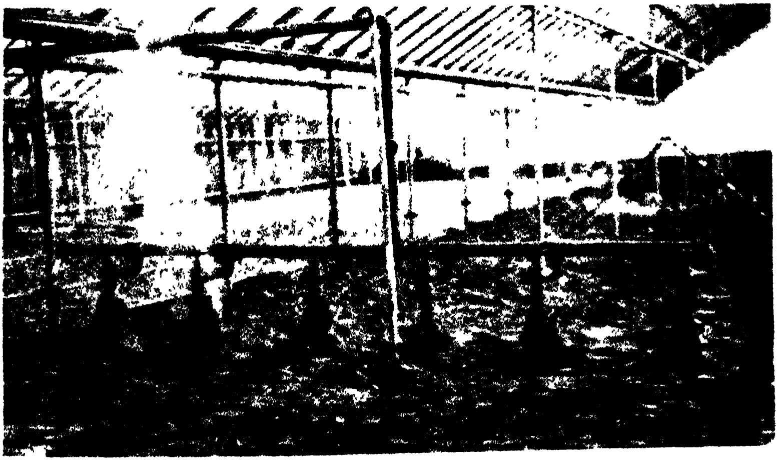
The carbon bisulfide was placed in a steel drum and steam under 50 pounds pressure allowed to pass through, volatilizing the material and forcing the gases into underground tiles, extending the length of the bed at a depth of about 16 inches. A high mortality of centipedes and other soil-infesting forms was secured.

In the course of investigations to control the greenhouse centipede (*Scutigerella immaculata* Newp.) carbon bisulfide proved one of the most effective soil fumigants. However, since this centipede, which has become a general and serious pest of lettuce and other greenhouse crops in Indiana, occurs at almost any depth down to 36 inches, depending on soil conditions, difficulty was experienced in securing complete treatment of all possible infested parts of the ground benches.

A method of volatilizing the carbon bisulfide, so that the gas completely permeated the beds, was devised and tested at Indianapolis, in February, 1928, and proved quite efficient for this and other soil animal pests. Since it may prove valuable for general soil fumigation purposes, the method used is described for the benefit of other workers.



Container in which carbon bisulfide was vaporized. A-30 gallon tank in which CS_2 was placed. B-Steam inlet. C-Outlet attached to underground tile.



Regular movable connection for sterilizing soil. This was used in the CS_2 fumigation study to first heat underground tile and avoid condensation near inlet.

The plot treated was a ground bench, 11 feet wide and 175 feet long equipped with six 4-inch tiles previously installed for steam sterilization. They extended the length of the bed, buried at a depth of about 16 inches with the steam inlet in the center of the bed.

The apparatus consisted of a 30-gallon steel oil drum, placed on a platform in a horizontal position, with the small opening in the end fitted with a three-fourths inch pipe and globe valve for the entrance of the steam. The larger hole in the side of the tank was connected with a 2-inch pipe which was inserted in the underground tile. This served as an outlet for the steam and evolved gases formed in the tank. A piece of hose in the steam line allowed changing of the position of the tank without disconnecting the pipes.

In fumigating, the tiles were first heated with steam to prevent condensation at the inlet. Each one was then fumigated separately. The carbon bisulfide (15 pounds for each tile) was poured into the tank and steam under 50 pounds pressure was allowed to run through the tank and into the tile, carrying the evolved gases with it. This mixture then spread into the adjacent soil. The carbon bisulfide vaporized very rapidly, only a few minutes being required to drive the whole charge into the soil. The odor of the material could be readily detected at the ends of the bed (85 feet from the point of entrance) within two minutes after the steam was turned on. After the carbon bisulfide had been entirely volatilized, steam was forced into the tile for about 15 minutes to insure even distribution of the gases throughout the soil. Examinations made at the completion of the fumigation showed the soil to be thoroughly and evenly impregnated with the carbon bisulfide fumes. The bed was spaded 48 hours later in preparation for replanting and the odor of the material was still very noticeable.

A month after the treatment no live centipedes, millipedes, earthworms or other soil-infesting forms were found and the lettuce planted two days after treatment showed an unusually vigorous growth.

A SOIL SIFTER[1] FOR SUBTERRANEAN INSECT INVESTIGATIONS

By M. C. LANE, *Assistant Entomologist*, and F. H. SHIRCK, *Junior Entomologist*, *U. S. Bureau of Entomology*

ABSTRACT

A soil sifting machine to facilitate investigations of subterranean insects, especially wireworms, is described.

INTRODUCTION

Anyone who undertakes to study the habits of soil insects is handicapped by the difficulty of determining their subterranean movements. Examination of the soil to obtain information on the depth at which hibernation occurs, degree of infestation, or to check the results of the application of a fumigant or other poison is at best tedious and subject to considerable error. In the course of our wireworm investigations a soil sifter has been developed which meets some of the difficulties presented by this problem. (See Plate 21, Fig. 1.)

CONSTRUCTION OF SIFTER

The frame is made of 3″x3″ material. The upright pieces are 30 inches long, the side rails 31 inches and the end rails 23 inches. The rails and uprights are mortised and fastened together with screws. The shaker bed (Plate 21, Fig. 3, A) measures 21½ inches by 28 inches (inside dimensions) with a distance of 2½ inches between the upper and lower screens. Owing to the severe strain which is placed on this part when the sifter is in operation, it is necessary that the corners be reinforced with iron corner braces. These are secured by means of small stove bolts. Two superimposed screens are used. The top screen (Plate 21, Fig. 3, E) is galvanized iron and of ¼ inch mesh and serves to break up the soil and also to remove coarse material such as sticks, stones, and other debris. After passing through the top coarse screen the soil falls on the finer screen (Plate 21, Fig. 3, B) below where the final sifting takes place. The bottom screen can be of any desired mesh, but for most soil insects a screen containing 12 meshes to the inch is fine enough. Ordinary window screening was found to be satisfactory in this work.

The mechanical principle upon which the sifter operates can be readily understood from a study of the illustrations. The drive shaft (Plate 21, Fig. 1, D) which is made of metal, has a 3-inch U-bend in it to which

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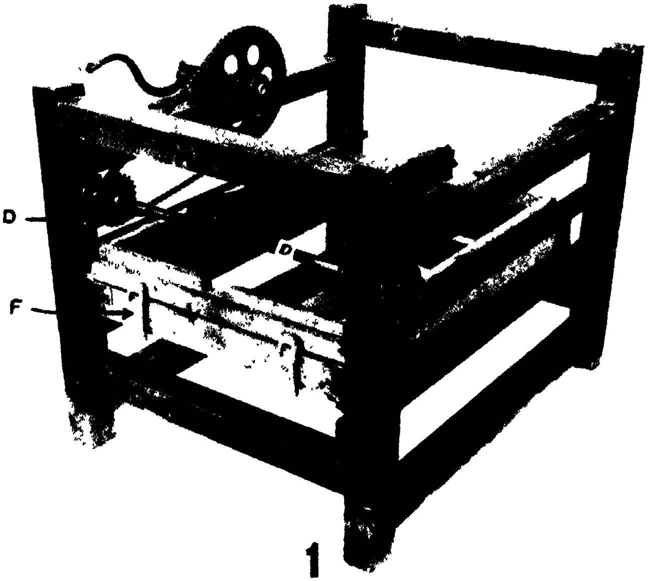
[1] The soil sifter herein described was developed in connection with wireworm investigation in the Pacific Northwest.



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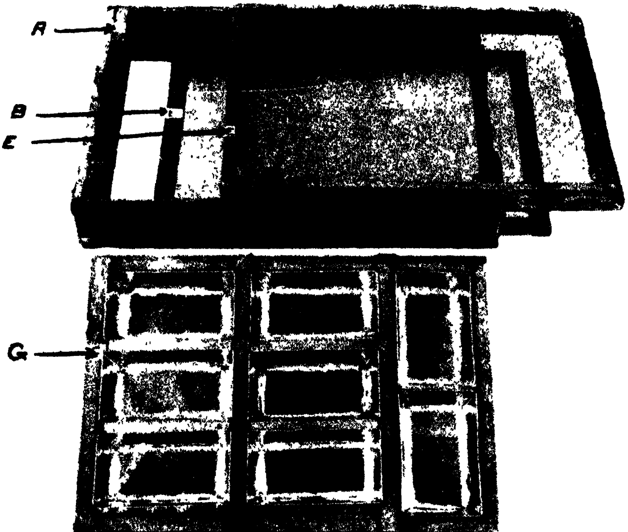
1.— Soil Sifter: (D) Drive Shaft· (F) Screen locks or fasteners



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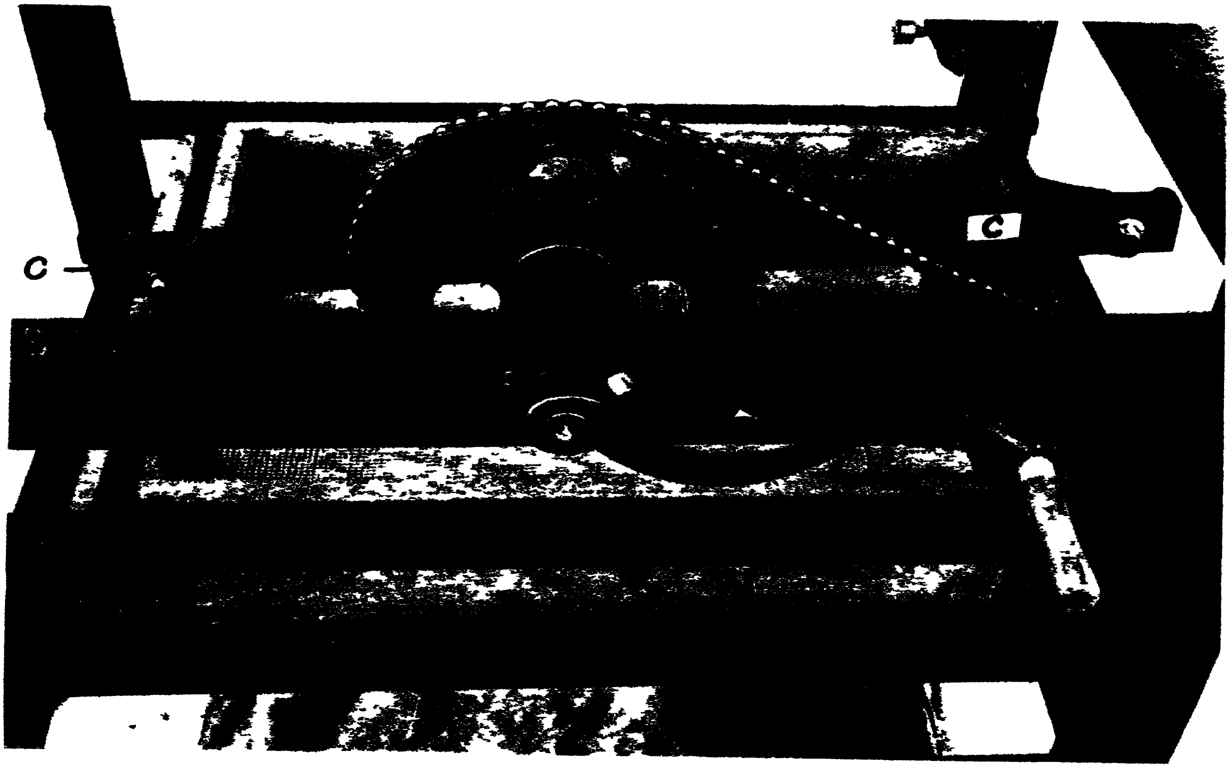
3.—(A) Shaker bed of soil sifter: (B) Lower fine screen:
(E) Upper coarse screen (F) Pan sieves.



Soil Sifter showing close up view of crank shaft connecting rod c and drive shaft the connecting rod (Plate 22, Fig. 2, C) is attached. The other end of the connecting rod is fastened to the shaker bed.

The connecting rod is made of oak wood and is equipped at each end with a bearing of babbitt metal. These bearings were prepared by pouring molten babbitt metal into holes bored in each end of connecting rod. After cooling, holes were bored in the metal to the proper size to receive the drive shaft at one end and the shaker bed pin at the other end. The attachment to the drive shaft was made by sawing, with a hacksaw, a slit four inches in length through the end of the connecting rod, and removing a rectangular piece of wood containing the upper half of the metal bearing. This allowed the drive shaft to be placed on the bottom half of the bearing, after which the upper piece was replaced and bolted down with cross bolts.

Thus it will be seen that as the drive shaft revolves the screens are shaken violently back and forth. The sprocket wheels are in the ratio of 1 to 2; that is, one turn of the crank produces two revolutions of the drive shaft and two complete oscillations of the screens. The screens travel a distance of six inches at each stroke.

OPERATION OF SIFTER

In operating the sifter, five or six shovelfuls of soil are placed in the top screen and the handle is turned, slowly at first to prevent soil from being shaken out over the end of the screen. After most of the soil has has passed through the top screen, the latter is removed by releasing the fasteners (Plate 21, Fig. 1, F) which hold it in the shaker bed and simply drawing it out. The fasteners are then turned again to secure the lower screen and the sifting is resumed. At this time the crank may be turned at the rate of about fifty turns per minute. It was found that the soil will pass through the screen more readily when one hand is used to keep it distributed while the sifter is in motion. After sifting has continued for a short time most of the soil will have passed through the screen, leaving a small residue of soil granules, insects in various stages, and other objects large enough to be retained. This residue can be quickly and easily examined, after which it may be discarded by partially drawing out the screen and brushing with a whisk broom. While it is possible that some of the very smallest larvae may be shaken through the 12-mesh screen, this method of examining soil yields quicker and more accurate results than any other method known to us.

In rearing wireworms through the egg and early larval stages, the writers have made use of "40-mesh soil," that is to say, soil sifted through a brass screen containing 40 meshes to the inch. Eggs of most of the injurious species of Elateridae indigenous to the northwest can be separated from this soil by sifting through the 40-mesh screen. The sifter previously described can be used to advantage in preparing the 40-mesh soil previously mentioned, by substituting in the shaker two screens measuring 20 and 40 meshes to the inch respectively. The soil, however, should first be passed through a 12-mesh screen before it is placed in the 20-mesh screen for sifting. The fine soil is caught on a piece of canvas or tray as it passes through the 40-mesh screen. It should be placed in air-tight containers until ready for use to prevent drying out.

Another advantage of this sifter is that it also provides as explained below a convenient laboratory method in large scale biological investigations for separating at one operation eggs or small wireworm larvae from the soil taken from a number of rearing cages.

A shallow rectangular pan with its bottom removed and replaced with a 40-mesh screen soldered on, serves as a sieve.

Eight of these pans as shown in Plate 21, Fig. 3, G, may be placed in a frame and this frame then fitted in the sifter, thus sifting in separate compartments, the contents of eight 2-ounce rearing boxes at one operation.

COST OF SIFTER

The total cost of labor and materials (not including wire screens and pans) used in constructing this sifter, will vary somewhat according to local prices, but should be approximately as follows:

Lumber	$ 5.00
Metal parts	12.00
Labor (blacksmith)	3.00
Labor (carpenter)	15.00
	$35.00

The cost is moderate and is justified in consideration of the time and labor which the use of the machine saves.

TYPES OF SOIL USED IN SIFTER

While the greater part of the soil used in our experiments was of volcanic origin it varied to a considerable extent in texture. Many types have been sucessfully passed through this sifter including heavy clay loams. It is thought, therefore, that with a change in size of screen this machine can be adapted for use in many sections having diversified

A NEW BENEFICIAL BEETLE IN MASSACHUSETTS

By W. D. WHITCOMB, *Mass. Agric. Experiment Station, Market Garden Field Station, Waltham, Mass.*

ABSTRACT

Cantharis andersoni Frost, a recently determined species, has increased rapidly in eastern Massachusetts since 1920. It feeds freely on most aphids common in the locality, and in cages has killed and devoured the larvae of several fruit and vegetable nsect pests.

In the summer of 1920 specimens of a Cantharid beetle were collected in Belmont, Mass., by Mr. Charles S. Anderson, then employed at the European Corn Borer Laboratory. These were sent to Mr. C. A. Frost of Framingham, Mass., who determined them as *Cantharis* (*Telephorus*) *andersoni*, sp. nov., and published the description with notes in Psyche, Vol. 29, p. 4, 1922.

Mr. Frost's description states that this species has the size and shape of C. *rotundicollis* Say, but can be easily distinguished by the entirely testaceous color except for several characteristic black, or at least dark, piceous areas; the orbicular thorax; and the densely pubescent sculpture of the elytra becoming strongly granulato-rugose to the apex.

Specimens were also collected at Mt. Desert Island, Maine, in 1919 and 1921 by Dr. Charles W. Johnson of the Boston Museum of Natural History, and the owner of the estate where Anderson made his collections reported that these insects were first noticed in 1918 in small numbers. It was also reported that they were collected on Japanese barberry, English elms, hedges, and grasses.

Since that time they have increased rapidly in eastern Massachusetts, particularly in Middlesex County, and during 1927 and 1928 they were observed in hundreds about gardens and orchards. Dozens of requests to identify them and to recommend treatment for controlling them were received.

There is one generation each year, the winter being spent in the larval stage in cells about four inches below the surface of the ground. At Waltham in 1928 pupation took place about the middle of May and the adults began to emerge May 30. During the month of June the beetles were very active, especially at dusk on warm evenings. They were noticeably abundant on apple trees and grape vines but could be found on practically all garden and orchard plants.

Beetles belonging in this family, *Cantharidae*, are predaceous on aphids and have occasionally been reported to be of economic importance, especially on the Pacific Coast where *Podabrus comes* Lec., *P. tomentosus*

Say, and *Cantharis divisus* Say are recorded by Essig as feeding freely on various species of aphids, and *C. consors* Lec. on the citrus mealy bug.

Apparently *C. andersoni* has feeding habits similar to the Pacific Coast species and attacks many of the common plant lice in this section. Caged specimens feed ravenously on the green apple aphis, the melon aphis, the green peach aphis, the black cherry aphis, and a green aphis on currant.

In addition they attacked and devoured larvae of the common asparagus beetle, imported cabbage worm caterpillars, undetermined green geometrid larvae, grape plume moth larvae, leaf roller larvae (Eulia sp.). and apple tree tent caterpillars. The large tent caterpillars were often ignored while smaller insects were plentiful but eventually several of them were killed and at least partly eaten, but it was evident that these were only starvation diet. Against the larger larvae the attacks were intermittent and usually more than one beetle participated. After a few bites they retired to observe the effect on the victim, renewing the attack after five minutes or longer.

When food became scarce in the cages there was evidence of cannibalism.

The large number of these beetles present during the last two years has had a noticeable effect on the aphids, and the fact that they are apparently well established and increasing promises to add another beneficial insect to counteract the ravages of the injurious species in Massachusetts.

Scientific Notes

Distribution of *Phthorimaea operculella* Zeller.—I collected specimens of this species (determined at British Museum) at the lights on the ship standing off Samarang, Java, March 6, and Townsville, Queensland, March 17. I do not think they came from potatoes on board, as they were with various insects evidently from the shore, and we did not notice them out at sea. The records are of some interest as showing the tendency of the insect to fly long distances, aiding its spread over the world.

T. D. A. COCKERELL

Talc and Mica Dusts as a Control for Lepidopterous Larvae.—During the summer of 1928 the writer conceived the idea of using finely ground mica dust as a mechanical barrier to prevent the entry of Oriental Peach Moth larvae into twigs and fruit. In insectary tests over 90 per cent of the recently hatched larvae were killed before they reached a point of entry. Experiments carried out at the same time with talc proved that this dust was even more effective than mica dust in killing the young larvae. A limited test with these two dusts used against recently hatched larvae of the codling moth showed that talc and mica dusts affect the larvae of this insect in the same way as they affect the Oriental Peach Moth larvae.

Observations on the young larvae as they came in contact with the dust and their subsequent struggles to free themselves of the clinging particles, indicated that the effect of the dusts on the larvae was a physical rather than a chemical one. The results obtained with these two dusts in killing the larvae named, and observations made on the way they affect the larvae, indicate that these two dusts have possibilities as a control for the young larvae of those insects which lay their eggs in such a position that the larvae are forced to crawl over the surface of the plant to reach a point of entry.

BYRLEY F. DRIGGERS, *N. J. Agr. Expt. Station*

A Suggestion for a Possible Application of Ovipositional Chemotropism.—In August, 1925, the writer conducted the following test:

Fifty males and fifty females of a soil-infesting insect were confined in a wire cage placed over a flat box of grass grown from seed in clean soil. A small cup containing a chemical was placed in one corner of the box. After six days the box of turf was examined and the location of the eggs noted. The results indicated that there had been a decided preference for the vicinity of the chemical as a place for oviposition. Similar results were obtained in a duplication of this test.

These tests, although not exhaustive, confirmed in the writer's mind the possibility of artificially localizing oviposition by the use of a chemical. It is evident that the artificial localization of eggs (and the consequent young) on a large scale would tend to permit limitation of the area necessary to be treated for the destruction of these, thereby effecting a decrease in expense for insecticide and labor.

Furthermore, since the individuals to be destroyed are the immature stages of the next brood, the application of the insecticide for their destruction may be made at any time during a large portion of their existence, if not their entire existence, in the original oviposition medium.

An essential phase of this suggestion is the use of chemotropism to facilitate the destruction of *individuals of a subsequent brood*, rather than those which respond to the stimulus. In view of the fact that traps for catching large numbers of gravid females have not been perfected, the utilization of an artificial oviposition stimulus as indicated above would seem to have a place in insect control.

The names of the insect and the chemical used in the above mentioned experiment have not been given, since to do so would in no way influence the general principle discussed in this article, and might give the erroneous impression that the use of this chemical was being recommended for the control of the insect in question.

J. WILLIAM LIPP, *Assistant Entomologist, Bureau of Entomology,*
United States Department of Agriculture

***Copidryas cosyra* Druce, An Enemy of Cactus on the West Coast of Mexico.**—Hunter *et al*[1] listed 324 species of insects associated with cactus in the United States. Ninety-two of these were injurious species. During the course of the writer's investigation of cactus insects in North America for the Commonwealth Government of Australia an injurious species additional to those listed by Hunter was taken. On August 7, 1922, at Ranchita, near Hermosillo, State of Sonora, Mexico, lepidopterous larvae were found feeding externally upon a Cylindropuntia of the *Imbricatae* series.

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[1] The Principal Cactus Insects of the United States. Hunter, W. D., Pratt, F. C. and Mitchell, J. D., Bur. Ent. Bull. 113, 1912.

These larvae were approximately two inches long, very robust, and light brown in color. From the nature of their injury they appeared capable of considerable damage. However, failure to find the species at other points visited on the west coast indicates that it is rare. This insect was identified by the Taxonomic Division, Bureau of Entomology, as *Copidryas cosyra* Druce. Mr. Carl Heinrich informs me that Druce's type is labelled "Mexico," but that the National Museum has other specimens reared from material collected at Phoenix, Arizona. The species is therefore a valid addition to the insect fauna of Cactaceae in the United States.

J. C. HAMLIN, *Bureau of Entomology, Salt Lake City, Utah*

Sulphur in the Control of Mites in Parasite Breeding Laboratories. The recent work of S. E. Flanders, of California, in breeding *Trichogramma minutum* Riley in large numbers in the eggs of *Sitotroga cerealella* (Olivier) has stimulated much interest in the rearing of this important egg parasite. Much of the work of the past season has been seriously interfered with by mites that have destroyed the *S. cerealella* in the laboratories. At the Colorado Agricultural Experiment Station, where work in this connection was started in August, 1927, two species of mites became so numerous that production was practically stopped as early as May, 1928. These were *Pediculoides ventricosus* (Newport) and a large Gamasid that has been determined only to the genus *Seius*. The Gamasid did the more damage early by feeding upon the eggs, but later the *P. ventricosus* became the more serious. It was found feeding upon the larval, pupal, adult and to some extent upon the egg stages

Our work on this project during the summer has been largely to devise methods to avoid or control the mites. Many materials have been tested for their killing and repelling effects. Sulphur has proven the material of most promise. It has been demonstrated to have a definite action upon the Gamasid mite, but it is rather difficult to get a definite check on the effectiveness against *P. ventricosus*. In repeated tests with the Gamasid mite 100 per cent kills of the nymph were secured when they came into contact with the sulphur immediately after hatching. They are not seriously injured if they have been out of the egg an hour before coming into contact with the sulphur. Upon the discovery of this, we began to use a dusting sulphur freely about the breeding laboratory. The first application was made July 19. There was an immediate decrease in the amount of "rash" caused by the *P. ventricosus* on the workers in the laboratory. A light coating of the sulphur was maintained over the grain bins and other fixtures and later much of the grain was dusted freely. The results are that there has been a very marked decrease in the number of both species of mites and a steady increase in the number of moths. The daily egg production from the surplus moths collected daily dropped from 100,000 in April to as low as 1000 during a part of July when the mites were the most numerous. A steady increase since August 1 has brought the egg production up to 15,000 or 20,000 in spite of the fact that during the last several weeks all of these eggs have been taken to another laboratory to infest another supply of grain. The sulphur does not seem to be injurious or objectionable to the grain moth or its larvae.

While these results are not entirely conclusive, they seem to warrant the publishing of this note at this time that others may make observations in the same connection.

GEORGE M. LIST, LESLIE B. DANIELS and CARL J. BJURMAN

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1928

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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There has come to the Editor's desk a suggestion to the effect that elimination of verbosity is desirable in the case of some JOURNAL articles and we all endorse that for the paper by the other man. It is further suggested that the Editor or a member of the Advisory Committee tactfully edit and advise changes in somewhat the same manner as is done by editorial agencies in various institutions. This would require the expenditure of more time than most would be willing to give to the rather thankless task of bettering the author's manuscript—it should mean a full time Secretary and Editor and this may come in the not distant future. There is no question as to the existence of verbosity in certain published articles and under present arrangements the author pays if he exceeds the somewhat arbitrary six page limit. It does not seem to be particularly effective in promoting conciseness. More frequently the author eliminates entire sections or pays, usually the latter. The Editor here suggests two or three recasts of an article, each for greater clarity, comprehensiveness and conciseness. The burden of the story can usually be brought within much smaller limits than in the first draft. We believe it a mistake to lean too heavily on the editor. Do your own phrasing and thus cultivate a habit of expression which ultimately will call for little editing—remember that the spoken word can not be edited. There was also a criticism of the restricted viewpoint of certain writers. There should be either a closely limiting phrase or the author should exhibit in his discussion a familiarity with all phases of his topic. This does not mean diffuseness. Our aim should be comprehensive concision, a not impossible ideal if a man really knows his subject. Scan your article more than once to see if it is really comprehensive. The author might well give a moment to the wording of the title of an article. Try writing running titles from the author's phrasing and one soon perceives cases where a little thought would result in a shorter title with the important word where it catches the eye. Compare, for example, "Observations on the Life History and Habits of the Codling Moth in the Rocky Mountain Region in 1928" with "Codling Moth Studies in Colorado, 1928." The latter tells nearly as much as the former and has the advantage of giving the most important word first, unless one wishes to imply that in studies of an insect, observation is comparatively infrequent?

Current Notes

Dr. M. D. Leonard of Cornell University, visited the Victoria, B. C., laboratory late in August.

Mr. E. P. VanDuzee, curator of insects, California Academy of Sciences, spent September 12 to 15 working in the U. S. National Museum collection of Hemiptera.

Wm. B. Gurney, Government Entomologist, Department of Agriculture, Sydney, New South Wales, Australia, spent August 23rd and 24th inspecting the entomological work of the Kansas Agricultural Experiment Station.

Dr. C. F. Adams, of the State Board of Health, Indianapolis, Ind., recently spent considerable time in the Division of Insects, U. S. National Museum examining recent literature on Diptera.

Mr. C. H. Alden, Entomologist, Georgia State Board of Entomology, visited the field laboratory of the Bureau of Entomology at Fort Valley, for several days in the latter part of August.

Mr. S. W. Frost expects to leave New York City January 10th, 1929, for Panama where he will spend six months collecting and studying leaf-mining insects, possibly going into Costa-Rica and Guatemala.

Mr. G. S. Matthews, of the Entomological Branch, terminated his appointment on Oct. 14 and is now taking post-graduate studies in agronomy at the Michigan Agricultural College, Lansing, having been awarded the Kellogg Fellowship.

Professor R. W. Harned, State Entomologist of Mississippi, and Troy Thompson, Nursery Inspector for the State of Alabama, were recent visitors at the Biloxi, Miss., field laboratory of the Bureau of Entomology.

Doctor J. L. Horsfall, who has been Entomologist with the Bayer Company, Inc., for the past two years, resigned July 1st, to accept a position with The American Cyanamid Company, New York City.

Dr. Roger C. Smith, who is on a year's leave of absence from the Kansas Agricultural College, is now established in his new temporary position at Port-au-Prince, Haiti, and seems pleased with the equipment and prospects.

While on leave of absence in England Mr. C. R. Twinn, Entomological Branch visited the headquarters of the Imperial Bureau of Entomology, London, the Farnham Royal parasite laboratory and Rothampsted Experimental Station. Mr. Twinn returned to Ottawa on Oct. 1.

According to *Science*, Dr. F. E. Lutz of the American Museum of Natural History, and Dr. William Morton Wheeler, of the Bussey Institution of Harvard University, have recently been elected members of the Corporation of the Mount Desert Island Biological Laboratory.

Dr. B. Trouvelot, of the University of Agriculture, Paris, Dr. Efflatoun of Egypt, and Wm. B. Gurney, Entomologist in the Department of Agriculture, Sydney, New South Wales, Australia. have been working at the Citrus Experiment Station of the University of California.

Mr. A. H. MacAndrews completed his spruce budworm studies in Cape Breton Island and terminated his appointment with the Branch early in September. Mr. MacAndrews has resumed his duties as Professor of Forest Entomology in the School of Forestry at Syracuse University.

Dr. Karl Friederichs of the University of Rostock, Germany, is giving the lectures in the graduate course on the principles of Applied Entomology at the University of Minnesota. These lectures were given last year by Professor R. A. Wardle, of Manchester University, England.

On September 13, Dr. Walther Horn, director of the Deutsches Entomologisches Institut, left the Museum after spending about three weeks working in the U. S. National Museum collection of Coleoptera. While here Dr. Horn named much of the undetermined material of the family Cicindelidae.

Centeter cinerea Aldrich, the introduced parasite of the adult Japanese beetle, was released in large numbers during July and August at Bridgeport, Conn., Harrisburg, Pa., and Noble, Pa., Following the release of the flies many beetles were recovered upon which eggs had been deposited.

Dr. E. A. Schwarz, the well-known coleopterist of the Bureau of Entomology, died October 15. On the afternoon of the sixteenth a memorial meeting was held in the U. S. National Museum, and several of the older entomologists spoke appreciatively of his life and work.

Messrs. M. C. Lane and K. E. Gibson, of the Bureau of Entomology, have been transferred from Toppenish, Wash., to Walla Walla, Wash., where the main wireworm field laboratory will now be located. F. H. Shirck will continue his studies at Toppenish and act in charge of the sublaboratory there.

Mr. R. Glendenning, of the Agassiz, B. C., Laboratory, who has been doing considerable work on European earwigs, reports that the control work conducted by the Vancouver authorities resulted in an 85 per cent kill of the earwigs. The total cost of the campaign was slightly more than $20,000.00.

Mr. H. F. Hudson of the Strathroy, Ont., Laboratory, who met with a serious accident on August 21, by falling and breaking his leg while collecting moths at night is confined to the St. Joseph's Hospital, London, Ont. Mr. A. A. Wood is acting-in-charge of the laboratory during Mr. Hudson's absence.

Dr. Paul Vayssiere, associate director of the Entomological station of Paris, was a visitor at Tallulah, La., September 3 to 6. He was greatly interested in the organization and work of the Delta Laboratory, particularly in demonstrations of dusting cotton with ground machines and airplanes. He also visited the field stations at Mound and New Orleans.

Dr. R. T. Tillyard, Commonwealth Entomologist of Australia, and Mr. F. Muir, Entomologist of the Experiment Station of the Hawaiian Sugar Planters' Association, visited the Department of Entomology at the Kansas State Agricultural College on August 26, 27, and 28. While there, a trip was made to the insect fossil beds located near St. Elmo, Kansas.

Dr. Elmer D. Ball, formerly director of research in the U. S. Department of Agriculture, and assistant secretary of Agriculture, recently in charge of celery insect investigations for the Florida State Plant Board, has been appointed dean of the College of Agriculture and Director of the Agricultural Experiment Station at the University of Arizona, effective October 1.

On August 15, B. R. Coad, in charge of the field laboratory of the Bureau of Entomology, at Tallulah, La., with R. E. Mitchell, pilot, took off for El Paso, Tex., in the newly purchased Stinson Detroiter airplane, en route to Tlahaulilo, Mexico, where he will inaugurate studies of the migration of the moth of the pink bollworm.

In the codling moth work at the Yakima field laboratory of the Bureau of Entomology, during the years 1922 to 1928, inclusive, 180 laboratory tests of ovicides have been made, using a total of more than 50,000 codling moth eggs. In the same period 900 laboratory tests of larvicides have been made, using 4,500 apples and 45,000 hatched larvae.

Mr. C. B. Hutchings with the assistance and cooperation of a number of Branch officers prepared and presented exhibits of entomological interest at the Central Canada Exhibition, Ottawa, Aug. 21–27, and at the Canadian National Exhibition, Toronto, Aug. 27–Sept. 8. As usual the exhibits attracted a great deal of attention from the public and were undoubtedly of considerable educational value.

According to *Science*, Dr. D. M. DeLong made the presentation address on October 27, when the Edward L. Rice scholarship fund was presented to Ohio Wesleyan University, in recognition of the services of Professor Rice as head of the Department of Zoology for a period of thirty years. This fund was created by thirty of Professor Rice's students in zoological and botanical science.

Mr. G. F. Moznette, in charge of the pecan insect laboratory of the Bureau of Entomology at Albany, Georgia, spent August 1 to 4 at Spring Hill, Ala., near Mobile, conducting control experiments with the black aphid of the pecan, ***Myzocallis fumipennellus*** Fitch, which has been causing serious damage to pecan trees in the vicinity. The feeding of this aphid leads to defoliation.

Dr. B. A. Porter, of the Vincennes, Ind., field laboratory of the Bureau of Entomology, attended the summer meeting of the Indiana State Horticultural Society at Evansville, Ind., August 2, and the meeting of the Kentucky State Horticultural Society at Henderson, Ky., August 3. At the latter meeting the oriental peach moth, which has recently appeared in southern Indiana and western Kentucky, was informally discussed.

Recent appointments in the Bureau of Entomology have been announced with field assignments, as follows: W. G. Bruce, Fargo, N. D.; R. A. Roberts, Uvaldel Tex., C. T. Blanz, Bell, Md.; E. S. Parkinson, Columbus, Ohio; J. H. Russell, E, Paso, Tex.; O. H. Lovell, San José, Cal.; C. B. Wisecup, Sanford, Fla.; R. L. Wallis, Melrose Highlands, Mass.; J. Dalton, St. Francisville, La.

The following by termination of appointment or by resignation have quit the employ of the Canadian Entomological Branch: W. E. Lindsay, Ottawa; W. A. Squires, Fredericton, N. B.; G. S. Matthews, F. F. Smith, Chatham, Ont.,; R. H. Handford, Treesbank, Man.; H. E. Gray and G. F. Manson, Lethbridge, Ala.; Professor G. J. Spencer and G. L. Giasson, Chatham Parasite Laboratory; Geoffroy Beall, Victoria, B. C.

According to *Science*, the Government of France has conferred upon Dr. L. O. Howard, of the Bureau of Entomology, the rank of officier de la Legion d'Honneur, as a promotion from the rank of chevalier of the legion. Dr. Howard has recently received honors from Hungary, having been made honorary member of the Hungarian Royal Society of Natural Sciences and of the Entomological Society of Hungary.

A meeting of tree specialists was held September 17 at the Bartlett Research Laboratories, Stamford, Conn., at which brief talks on insects were given by Dr. E. P. Felt, director and chief entomologist of the laboratories, Mr. A. F. Burgess, in charge of Federal gipsy moth work, Professor C. C. Hamilton, associate entomologist of the New Jersey Agricultural Experiment Station, and Dr. W. E. Britton, State Entomologist of Connecticut.

Following the Ithaca meetings, the following foreign entomologists visited the Entomological Branch, Ottawa, Canada: Dr. W. Saalas of Finland, Dr. D. D. deTorres and F. Silvela of Spain; Dr. K. C. Sullivan of Missouri, Dr. M. Schwartz of Germany, H. Horowitz and A. E. Stene of Rhode Island, Professor J. Gray of Florida, Dr. A. D. Imms, Rothamsted Research Station, Harpenden, and Mr. J. C. F. Fryer, Chief Entomologist to the Ministry of Agriculture, London, England.

Dr. F. C. Craighead, of the Bureau of Entomology, spent the first week of September at Asheville, N. C., reviewing the summer's work at the field laboratory at this point. He also spent a few days in the vicinity of the Mont Alto Forest School, Pa., with H. J. MacAloney, in studies of the white pine plantations in that region. The Mont Alto Forest School and the Pennsylvania State Forest Service gave them considerable assistance in this work.

Dr. J. McDunnough returned to Ottawa on Sept. 10, after spending nearly three months in Western Canada in connection with faunal studies. Dr. McDunnough first collected insects at Minaki on the Winnipeg river, Ont., then proceeded to Lethbridge, Alta., and later motored to Bozeman, Montana and made extensive collections in the Yellowstone National Park. During late August and early September collections were made at Waterton lakes and Banff, Alta. Dr. McDunnough reports extremely satisfactory results from his trip.

In the latter part of August, Mr. Arthur Gibson, Dominion Entomologist accompanied Mr. J. C. F. Fryer, Chief Entomologist to the Ministry of Agriculture, London, England, on a trip through Ontario and into Ohio and Michigan. The following points in Ontario at which the Branch is conducting investigations were visited: Niagara Falls, St. Davids, Vineland, Queenston, Simcoe, Beamsville, Strathroy, and Chatham. In Michigan, the Corn Borer Laboratory at Munroe was visited and also the laboratories near Toledo and at Van Harbor, Ohio. During the week of September 10, Mr. Gibson visited the Niagara Falls district and in company with Messrs. Baird and Ross investigated areas in which peach moth parasite investigations were being conducted. On October 3, Mr. Gibson accompanied Dr. Grisdale, the Deputy Minister of Agriculture, and Mr. C. S. MacGillivray of the Health of Animals Branch, to Belleville, Ont., where visits were paid to a number of local canning factories.

According to *Science*, Dr. Dayton Stoner has resigned his position as Assistant Professor of Zoology at the Iowa State University and has accepted an appointment as Associate Entomologist in the Bureau of Entomology to investigate truck crop insects at Sanford, Fla.; on May 1, 1929, Dr. Stoner will return to Syracuse, N. Y., to complete his studies of the birds of the Oneida Lake region, a project promoted by the New York State College of Forestry and the Roosevelt Wild Life Experiment Station.

Messrs. C. H. Phipps, Associate Entomologist, Dr. H. C. Hildreth, Horticulturist engaged in blueberry investigations, and Robert Chandler, Assistant Horticulturist, all of the Maine Experiment Station, Prof. K. H. Salman of the Department of Entomology, Massachusetts Agricultural College, Warren Pettigrew, of the Maine State Department fo Agriculture, and C. W. Collins, of the Gipsy and Browntail Moth Investigations, Bureau of Entomology, visited the blueberry maggot field laboratory, of the Bureau of Entomology, at Cherryfield, Maine, late in July and early in August.

Professor T. V. Ramakrishna Ayyar of the College of Agriculture, South India, who went on a tour abroad last year, spent the winter, spring and summer at Stanford University where he received the Doctor's degree (Ph.D.) in Zoology in October last. His thesis was on the 'Thysanoptera of India.' Dr. Ayyar has since returned to India after visiting many places in the States and making many friends and with many pleasant memories of the warm hospitalities enjoyed at the hands of many Entomologists. On his way back Dr. Ayyar spent some time in England and on the Continent. His present address is The Agricultural College, Coimbatore, South India, Lawley Road, P. O.

In the province of New Brunswick, collections of pupae and of larvae of the European corn borer were made at five points in Queens and Sunbury counties in the St. Johns river valley. This is the first report of the occurrence of the corn borer in New Brunswick. Scouting in the province of Quebec has resulted in only one collection being made in new territory—near St. Cyrille in Drummond county. Infestation record work has been completed for the season in Ontario and Quebec.

The following resignations in the Bureau have been announced: C. E. Abbott, Dallas, Tex.; B. E. Montgomery, Vincennes, Ind.; H. L. Ratcliffe, and O. R. Causey, Chadbourn, N. C.; R. W. Burgess, San José, Cal.; D. P. Ellington, Picayune, Miss.; J. E. Culpepper, R. P. Patty, B. A. Moers, C. F. Rainwater, J. K. V. Stewart, D. H. Ratcliff, G. A. Noel, F. B. Russell, S. T. Williamson, S. E. Jones, J. Randolph, J. G. Anderson, W. R. Gore, H. D. Tate and T. E. Dawson, Tallulah, La.; Winnifred S. Hull, Washington, D. C.; D. M. DeLong, H. C. Mason and D. F. Miller, Columbus, Ohio; P. E. Kiker, Jr., Toppenish, Wash.; C. W. Getzendaner, Alhambra, Cal.;

W. F. Senette, Baton Rouge, La.; C. H. Smith, Richfield, Utah; H. Beerman, Philadelphia, Pa.; T. E. Brouson, Madison, Wis.; Dr. L. H. Taylor, Washington, D. C.; D. G. Hall, E. E. Atwood, Melrose Highlands, Mass.; Mary L. Crossman, R. K. Day, Washington, D. C.

The Fourth Annual Conference of the International European Corn Borer Organization was held September 27 and 28, 1928. September 27 was spent at the European Corn Borer Development Farm, about 10 miles east of Toledo, Ohio, and at the Ohio State plots. Several fields where infestation of the European corn borer was most serious were also visited. The forenoon of September 28 was spent at the Federal and State laboratories at Monroe, Mich., and the general conference was held at Toledo in the afternoon. Preceding the general conference, committees representing the American Association of Economic Entomologists, The American Society of Agronomy, The American Society of Agricultural Engineers, and the American Farm Economic Association, spent three days in the field, investigating the corn borer situation. The joint report of these committees was presented at the general session of the conference on Friday afternoon. This report gave in considerable detail recommendations as to the needs for research on the European corn borer. There were approximately 150 in attendance at the general conference, consisting of scientists, administrative officials, and farmers interested in the general corn borer problem.

The Fifth Annual Conference of Entomologists working in Connecticut, was held at the Agricultural Experiment Station, New Haven, October 25, 1928, beginning at 10 o'clock a. m. Dr. W. E. Britton was elected chairman and 42 were in attendance. The following program was carried out: Greeting; W. L. Slate, Director, Experiment Station, New Haven; Progress in Mosquito Ditching in Connecticut in 1928, R. C. Botsford, New Haven; Some Entomological Features of the season of 1928, W. E. Britton, New Haven; Some Injurious Shade-Tree Insects in 1928, Dr. E. P. Felt, Stamford; New Phases in the Spread and Control of the European Corn Borer, L. H. Worthley, Boston, Mass.; Experiments with Oil Mixtures in Killing the Eggs of the European Red Mite, Dr. Philip Garman, New Haven; General Properties of Oil Sprays, Neely Turner, New Haven; Naphthalene Fumigation, Dr. Albert Hartzell, Yonkers, N. Y.; Glimpses of the Fourth International Congress of Entomology held at Ithaca, N. Y., Prof. J. A. Manter, Storrs; The Gipsy Moth and the Satin Moth, A. F. Burgess, Melrose Highlands, Mass.; Present Status of the Japanese Beetle in the United States, C. H. Hadley, Camden, N. J.; Some Aspects of Japanese Beetle Quarantine Enforcement in Conn., J. P. Johnson, Shelton; Control of the Asiatic Beetle, Dr. R. B. Friend, New Haven; Notes on Nursery Inspection in Connecticut, M. P. Zappe, New Haven.

Apicultural Notes

The fall meeting of the Connecticut Beekeepers Association was held in the State Capitol, Hartford, October 20.

Dr. M. C. Tanquary has accepted an appointment as Professor of Entomology in Charge of Apiculture at the University of Minnesota.

The annual meeting of the Wisconsin State Beekeepers' Association is scheduled for December 13 and 14. Professor H. F. Wilson, Madison, is Secretary.

The winter meeting of the Oregon State Beekeepers' Association has been arranged for November 22–24, and the Secretary is Professor H. A. Scullen, Corvallis.

The Winter meeting of the Minnesota Beekeepers' Association is announced to be held December 4 and 5. The Secretary is Otto L. H. Wille, St. Paul.

Professor F. Eric Millen, Guelph, Ont., Secretary, has arranged for the annual meeting of the Ontario Beekeepers' Association, at the Prince George Hotel, Toronto, November 27–29.

Professor C. L. Farrar, in charge of beekeeping at the Massachusetts Agricultural College, Amherst, visited the Bee Culture Laboratory of the Bureau of Entomology on September 11.

Mr. W. M. Howland has resigned his temporary appointment as bee inspector in Virginia to take up his duties as instructor in the Segregansett School of Agriculture, Bristol County, Mass.

Dr. John Renney, Aberdeen, Scotland, whose name is associated in the minds of beekeepers with the discovery of the cause of the Isle of Wight disease, died on August 30.

Professor F. B. Paddock, of the Iowa Agricultural College, Ames, Iowa, visited the Intermountain Bee Culture Field Station of the Bureau of Entomology, Laramie, Wyoming, during the week of September 10th.

Mr. John C. Ferris, of the East Coast Canning Co., Jacksonville, Florida, called at the Bee Culture Laboratory of the Bureau of Entomology on September 18th to discuss methods of bottling honey.

Prof. Shujiro Inomata, Entomologist at the Agricultural College, Tottori, Japan, visited the Bee Culture Laboratory of the Bureau of Entomology on September 25th. Professor Inomata states that courses in beekeeping will be given at the Agricultural College at Tottori.

Mr. Jess Dalton, of St. Francisville, Louisiana, for the past few years president of the Louisiana State Beekeepers' Association, was appointed a collaborator of the Southern States Bee Culture Field Station, of the Bureau of Entomology, on September 25th.

Recent visitors of the Bee Culture Laboratory of the Bureau of Entomology included Dr. W. W. Alpatov, of the University of Moscow; Mr. Victor M. Buck, of the Presbyterian School, Ebolowa, Cameroun, West Africa; and Dr. J. A. Nelson, of Mt. Vernon, Ohio, who was formerly connected with the Laboratory.

Mr. Roth Hamilton, of the firm of Hamilton, Wallace and Bryant, Los Angeles, California, large exporters of honey, conferred with Mr. Jas. I. Hambleton, of the Bee Culture Laboratory of the Bureau of Entomology, on Sept. 24th in regard to foreign honey markets. Mr. Hamilton stopped in Washington after an extended trip through Europe where he made a careful study of the honey markets.

The American Honey Producers' League sponsored an exhibit of honey which was shown at the annual convention of the American Dietetic Association, which met at the Willard Hotel, Washington, D. C., on Oct. 29 to 31. The success of the exhibit was in large part due to Dr. E. N. Cory, Secretary of the Maryland State Beekeepers' Association, who detailed members of the association to take care of the display.

A new bee-culture field Station, known as the Southern States Bee Culture Field Laboratory, has been established at Baton Rouge by the U. S. Department of Agriculture for which special funds were appropriated by the last Congress. The Louisiana State University provides laboratory facilities, heat, light, janitor services and assists in procuring scientific apparatus. Mr. W. J. Nolan has been in Baton Rouge since early July arranging for the experimental work.

Mr. R. S. Kifer, of the Bureau of Agricultural Economics, visited the Bee Culture Laboratory of the Bureau of Entomology on October 2nd to confer with members of the staff previous to his departure for the Intermountain States, where he will continue with the work on honey cost production studies and methods of apiary management upon which Mr. E. L. Sechrist, of the Bee Culture Laboratory of the Bureau of Entomology, has been engaged during the past summer. Mr. Kifer will make the final visit to all cooperators and close the work for the season.

Dr. Everett Oertel has recently been appointed an Assistant Apiculturist to fill a vacancy in the Southern States Bee Culture Field Station, of the Bureau of Entomology, recently established at Baton Rouge, La. He will devote his time largely to the study of floral sources of nectar, manipulation of bees, and other factors closely related to the production of honey. Dr. Warren Whitcomb, Jr., also of this station, attended the meeting of the Georgia State Beekeepers' Association at Macon, Ga., on Sept. 19th, where he outlined the work of the new Southern States Bee Culture Field Station.

The Bee Culture Laboratory of the Bureau of Entomology has just received two Pfund honey graders from the Munsell Color Co., of Baltimore, Maryland, which are to be assigned to the offices of the United States Trade Commissioners in London and Hamburg, where they will be available for use by foreign buyers of honey. Through the instrumentality of Mr. T. L. Ball, of the Superior Honey Co., Ogden, Utah, with the cooperation of several exporters of honey, and also the generous discount allowed by the Munsell Color Company, these graders are being sent abroad without cost to the Government.

Prof. H. F. Wilson, head of the Department of Entomology, at the University of Wisconsin, Madison, and also custodian of the Dr. C. C. Miller Memorial Library located there, visited the Bee Culture Laboratory of the Bureau of Entomology on October 23rd. After looking over the library of the Division of Bee Culture Investigations, he deplored the fact that many valuable and almost unavailable books were housed in such an inflammatory building. Noticing many of the gaps in the volumes of bee journals, he generously offered to transfer some duplicate material from the Miller Library to that of the Bee Culture Laboratory, as he fully agrees that the Department of Agriculture should possess the best possible library.

In the last number of the JOURNAL OF ECONOMIC ENTOMOLOGY mention was made that at the time granulated honey was discovered in the apiary of the Bee Culture Laboratory of the Bureau of Entomology the bees were found to be working largely on sweet clover. Since that time it has been determined that the granulation of the honey was due to the presence of melezitose one of the rare sugars, and it is quite evident now that the bees had finished working the true source from which the melezitose was derived, which was probably the scrub pine, a tree occurring in abundance in this part of the country. For this reason it has been impossible to determine definitely whether the melezitose was derived directly from an exudation of the scrub pines, or from honeydew collected from aphids.

Horticultural Inspection Notes

On October 8, 1928, the Plant Quarantine and Control Administration revised circular PQCA-218 "Restrictions Re Orchid Permits."

Mr. H. A. Horton was transferred from the port of Seattle, Washington, where he had been employed as Junior Plant Quarantine Inspector, to Nogales, Arizona, on October 10.

Mr. R. C. Elliott, who had been employed as Junior Plant Quarantine Inspector at Nogales, Arizona, since September 24, 1926, was transferred on September 21 to the port of New York.

Mr. Joe Milan, Charksville, Tenn., has been transferred temporarily to the Plant Quarantine and Control Administration, where he will conduct inspection work for the pink boll worm.

Recently Dr. M. C. Tanquary, who was formerly Commercial Beekeeper, Fargo, North Dakota, accepted a position as Professor of Apiculture, Department of Entomology, University Farm, St. Paul, Minnesota.

Mr. Herschell Fox, Junior Plant Quarantine Inspector assigned to the office of the Plant Quarantine and Control Administration in San Juan, Porto Rico, left San Juan on October 25 to assist temporarily at the port of New York.

Mr. D. B. Mackie, of the California Department of Agriculture, Sacramento, California, conferred with members of the Plant Quarantine and Control Administration in Boston, Mass., New York City, and Washington, D. C., about the middle of September.

Mr. C. V. Scott was transferred on October 3 from the port of New York to Seattle, Washington. Mr. Scott had been assisting at the port of New York since June 1, 1925, the date of his appointment with the Plant Quarantine and Control Administration.

Dr. J. H. Montgomery, Florida State Board, Gainesville, Florida, spent several days in Washington the middle of October to consult with members of the Plant Quarantine and Control Administration regarding fumigation studies and port inspection.

Mr. R. A. Fox of the New York office of the Plant Quarantine and Control Administration was engaged in the inspection and certification of apples and pears for export in the States of Washington and Oregon during the period September 26 to October 30.

Grapefruit, oranges and kumquats from the 1928 crop in the Lower Rio Grande Valley began to move on October 1 under Federal inspection and certification, as provided in Quarantine No. 64. The crop is reported to be considerably larger than previous years.

Mr. W. S. Fields, of the Washington office of the Plant Quarantine and Control Administration assumed charge of the inspection of special permit material grown in the vicinity of New York about September 15. Mr. Fields' headquarters are at 45 Broadway, New York City.

The proceedings of the ninth annual conference of the Western Plant Quarantine Board, held at Reno, Nevada, in 1927, have been published by the State Department of Agriculture of California, as Special Publication No. 85. Copies are available for distribution by that department.

Mr. Carl H. Spiegelberg, who was formerly employed as Junior Plant Quarantine Inspector at New York City, was given a temporary appointment to assist in the inspection and certification of pears and apples for export in the States of Washington and Oregon effective October 1, 1928.

Mr. Harry Sargent, who has been in charge of the work of the Plant Quarantine and Control Administration at the port of Astoria, Oreg., has been transferred to the port of New York, effective November 3. The port of Astoria has been closed so far as this Administration is concerned.

Mr. Geo. W. R. Davidson, who has been assisting Mr. R. L. Clement, Nursery Inspector of the New York State Department of Agriculture and Markets in narcissus inspections on Long Island, since August 14, was transferred, effective November 1, 1928, to the pink bollworm field service for duty in western Texas.

During the month of September, Messrs. A. J. Bruman and L. L. Spessard, of the Washington office of the Plant Quarantine and Control Administration, supervised the treatment of narcissus bulbs at North, Va., and Norfolk, Va., respectively. Mr. W. T. Dillard, stationed at the port of New Orleans supervised similar treatments at Scottsville, Texas.

Mr. George G. Becker, in charge of the pink bollworm field service, and Mr. R. E. McDonald, State Entomologist, Austin, Texas, spent several days in October conferring with members of the Plant Quarantine and Control Administration at Washington, D. C., concerning problems connected with the pink bollworm quarantine regulatory work.

The organization of the South Carolina State Crop Pest Commission has been modified during recent months. The names of the personnel and their titles are now as follows: Prof. Franklin Sherman, State Entomologist; Prof. H. W. Barre, State Pathologist; J. A. Berly, Assistant State Entomologist, and L. M. Fenner, Assistant State Pathologist.

During August and September, transit inspection of interstate shipments of nursery stock and other plant material has been carried out by the Plant Quarantine and Control Administration. This work is a continuation of the plan heretofore followed by the Federal Bureau of Plant Industry. The work in the eastern half of the United States is under the direction of Mr. R. A. Sheals, and that in the west is supervised by Mr. C. R. Stillinger.

Extracts from the Virginia Crop Pest Law together with Rules and Regulations are now in press, and it is expected that copies will be available for distribution after the latter part of November. This publication has not been available for a considerable period and there have been frequent requests for it in recent months.

A general European corn borer conference was held at Toledo, Ohio, on September 28, 1928, with a large attendance representing interested States, commercial concerns, and the agricultural press. A field trip included visits to the experimental plots at Bono, Ohio, and Monroe, Michigan, as well as into Ontario. The damage from this insect in the formerly heavily infested areas north of Lake Erie was found to be less than in previous years, owing to the institution of the most approved cleanup methods throughout the region.

Prof. A. E. Stene, Chief, Bureau of Entomology, of the Rhode Island Department of Agriculture, reports that the production and movement of five-leafed pines and Ribes in Rhode Island have recently been brought under a new set of regulations. Not only are special permits required for the transportation of these plants within or into the State, but they may not even be planted without such a permit. The harboring of *Ribes nigrum*, *aureum*, and *odoratum*, is prohibited. A blister rust control area is also legally established and defined, and penalties are provided for violations of the regulations.

The Federal pink bollworm quarantine regulations were amended effective November 15, 1928. Under this amendment, provision is made for the issuance of permits for the interstate movement of sterilized cottonseed to authorized oil mills located outside of but in the vicinity of regulated areas of Texas, New Mexico and Arizona, upon determination by the Plant Quarantine and Control Administration that reasonable necessity exists for such action. The authorization of such oil mills will depend upon compliance with such conditions as shall in the judgment of the Administration eliminate the risk of spread of the pink bollworm therefrom.

A public hearing was held by the Plant Quarantine and Control Administration on November 12 to consider the advisability of revising the satin moth quarantine to include the State of Vermont within the quarantined area. Surveys during the past year have demonstrated a very considerable spread on the part of this insect. At the time of the hearing it was proposed that 172 towns, covering approximately 5,116 square miles, be added to the regulated area. The most extensive of these areas are in Connecticut and New Hampshire and less spread has been found in Maine and Massachusetts. For the first time the satin moth has appeared in Vermont, where specimens were found at scattered locations in the eastern third of Windham county, and in the southeastern corner of Windsor county.

On October 18, the Secretary of Agriculture issued Notice of Quarantine No. 65, relating to the Woodgate rust. Under the regulations supplemental to this quarantine, the interstate movement of hard pines susceptible to this disease from the following counties of New York State: Clinton, Essex, Franklin, Hamilton, Herkimer, Jefferson, Lewis, Oneida and St. Lawrence, is prohibited. The pines thus far known to be attacked by the disease and brought under regulation at this time are: Scotch pine (*Pinus sylvestris*), Canary Island pine (*P. canariensis*), Slash pine(*P. caribaea*), Japanese red pine (*P. densiflora*), Corsican pine (*P. nigra poiretiana*), Stone Pine (*P. pinea*), Western yellow pine (*P. ponderosa*), Monterey pine (*P. radiata*), Loblolly pine (*P. taeda*), or Jersey pine (*P. virginiana*).

The Virginia Cedar Rust Law has been attacked on constitutional grounds and otherwise several times in the State courts without success. Two individuals took their cases through the lower courts into the United States Supreme Court. One case was argued before this court in the October term, 1927 and the law was declared constitutional in an opinion handed down February 21, 1928. In the October term of the court 1928 the second case was argued and on October 29, 1928 the Supreme Court again sustained the validity of the act, finding no issues requiring it to change its views as expressed in the opinion of the case previously cited. In this second case the court declined to hear arguments by counsel for the State. These decisions are of particular interest because regulatory laws of this nature seldom reach the United States Supreme Court for argument.

The alfalfa weevil is the only insect of any major importance in regard to quarantines in Wyoming at the present time. No additional counties have been found infested in that State during the past season. As a matter of fact, an infection discovered two years ago at Torrington in Goshen County and at Lusk in Niobrara County was conspicuous this year by its absence. Fields which were fairly heavily infested last year failed to reveal a single weevil during this year's scouting. The officials of the Department of Agriculture of Wyoming are conducting intensive ecological studies upon the alfalfa weevil, primarily for any scientific information which will be of value in the more intelligent promulgation of alfalfa weevil quarantines. Not only field studies in which all of the physical and climatical factors are involved are being conducted but experiments under controlled conditions of relative humidity in the laboratory are being carried on.

The eighth annual meeting of the International Great Plains Crop Pest Committee was held at the North Dakota State College, Fargo, North Dakota, September 12th and 13th, 1928. Those in attendance were as follows: W. G. Bruce, U. S. Department of Agriculture, Bureau of Entomology; A. G. Ruggles, State Entomologist, St. Paul, Minnesota; R. L. Shotwell, Experiment Station, Bozeman, Montana; C. N. Ainslie, Cereal and Forage Insect Investigation, Sioux City, Iowa; K. M. King, Dominion Entomological Laboratory, Saskatoon, Saskatchewan; H. L. Seamans, Dominion Entomological Laboratory, Lethbridge, Alberta; Norman Criddle, President, Dominion Entomological Laboratory, Treesbank, Manitoba; S. H. Vigor, Department of Agriculture, Regina, Saskatchewan; M. C. Tanquary, Commercial Beekeeper, Fargo, North Dakota; J. A. Munro, Secretary, Department of Entomology, Fargo, North Dakota; and C. B. Waldron, College of Agriculture, Fargo, North Dakota.

The Eastern Plant Board held its Annual meeting October 26, at the American Museum of Natural History, New York City. Dr. T. J. Headlee was reelected Chairman. The following program introduced topics for discussion: Japanese Beetle Control, C. H. Hadley; Discussion of the Status of Three Asiatic Beetles, Loren B. Smith; Perennial Apple Canker and Apple Tree Anthracnose, W. A. McCubbin; Federal Inspection in the Enforcement of Federal Quarantine, R. A. Sheals; Narcissus Inspection, Treatment and Certification, S. B. Fracker; Rose Stock Diseases, W. H. Martin; The Gipsy Moth Control Problem, A. F. Burgess; The Mexican Bean Beetle, Neale F. Howard; The Potato Tuber Moth, E. N. Cory; The European Corn Borer—Individual and Community Control, H. N. Bartley; Quarantine, R. S. Clifton. Others present were: Dr. W. E. Britton, J. Peter Johnson, Connecticut; Dr. J. F. Adams, Delaware; Dr. A. W. Gilbert, Massachusetts; R. B. Lott, Wm. Flemer, New Jersey; W. C. O'Kane, New Hampshire; C. P. Norgord, H. L. McIntyre, P. J. Parrott, R. D. Glasgow, B. D. Van Buren, Saul Phillips, New York; Dr. T. L. Guyton, Pennsylvania, A. E. Stene, Rhode Island; G. T. French, Virginia; H. L. Bailey, Vermont; W. E. Rumsey, West Virginia; C. H. Zimmer, U. S. Department of Agriculture.

Notes on Medical Entomology

Mr. R. W. Wells, of the Bureau of Entomology, returned to his field station, Beltsville, Md., on September 12, after conducting a series of tests of methods of cattle grub control at Herkimer, N Y.

Mr. J. L. Webb, of the Bureau of Entomology, has been transferred from the field force of the Division of Cotton Insects to the Washington force, Insects Affecting Man and Animals, and will assist in the administration of the Division.

Mr. R. C. Shannon, of the Rockefeller Foundation, returned to Washington August 20 after spending six months in Peru. Mr. Shannon was in the U. S. National Museum about six weeks working up some insects collected in connection with his investigations of verruga fever—a disease known only in Peru.

Wesley G. Bruce was appointed Assistant Entomologist in the Bureau of Entomology, September 5, and was assigned to Cattle Grub Investigations with headquarters at Fargo, N. D. During September he was engaged in a survey of the cattle-grub situation in the Red River Valley and at points in North Dakota, South Dakota, and Minnesota. He also attended the eighth annual meeting of the International Great Plains Crop Pest Committee, held at Fargo, N. D., September 12 and 13.

On August 4, Messrs. W. E. Dove and Frank Adams, of the Bureau of Entomology, were the victims of a tragic accident which resulted in the death of Mr. Adams. They were returning to their station at Uvalde, Tex., from a trip in an automobile to a near-by mountain canyon. In crossing what is usually a dry stream bed they encountered a sudden rush of water caused by a cloudburst higher up in the mountains. Both men and the car were swept down stream by the force of the water. Mr. Dove, by great good fortune, managed to lay hold of the branches of a tree, and some hours later was rescued from this position. Mr. Adams was not seen alive after the water struck the car. His body was found the next day, some distance below the river crossing. Mr. Adams was a temporary field assistant at the time of his death, and was assisting Mr. Dove in studies of goat lice. He held the degree of Master of Science from the Southern Methodist University, located at Dallas, Tex. He was a careful and conscientious worker and showed great promise as an entomologist.

ERRATA

Plate 14, facing page 552, amend legend to read as follows:

1. Effect of *Myzocallis fumipennellus* F. on pecan, (slightly reduced). Injured areas on leaflets, lower leaflet curling, upper leaflet with less advanced injury.
2. Defoliation caused by aphids on a caged leaf.

Plate 15, facing page 574, is printed upside down while the explanation reads as though it was right side up.

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